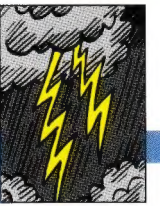
Why is it colder at higher altitudes?



METEOROLOGY

1. Cold air is lighter than hot air
2. Air is scarcer and retains less heat at higher elevations
3. The sun shines less at higher elevations

©1995 Nintendo

Air

It's colder at higher altitudes than on the flatlands. That's because air is thinner and scarcer at higher elevations, and it retains less of the sun's warmth that was stored during the day.

2 Air is colder at higher altitudes because air is scarcer there and retains less heat.

Photo © Rey / Explorer

High winds at a high elevation in the mountains can make the temperature feel even colder!

The higher one climbs, the lower the temperature goes. In fact the temperature drops 1 degree for every 489 ft (150 m) higher you go—even at the equator!

Air's There

The air around us acts as a greenhouse, monitoring our intake of solar heat, and at night slowing the loss of solar heat stored by the soil during the day. On a wide open prairie, the mattress of air surrounding Earth is thick and the temperatures are mild, so the thermal separations between day and night are faint. On a mountain, the mattress of air is deflated. The ground warms very quickly once the sun comes up, but it also cools rapidly when night falls. And in the mountains, the moving air, or wind, is more violent than over the prairies, so the chances of the temperature dropping are increased.

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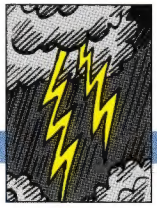
Why is there wind?



METEOROLOGY

1 Because of clouds

2 Because of the stars

3 Because of differences in temperature and air pressure

©1995 Nintendo

Wind

In the atmosphere, huge masses of hot and cold air move around and bump into one another. This movement creates a current of air, or wind.

3 The wind is created by differences in temperature and air pressure.

Photo © Clément/Explorer

Trees exposed to the force of the wind twist and flutter like flags on a pole.

Heat from the sun warms the soil. Being lighter, the warm ground air rises and is replaced by cooler, heavier air. This movement of air, caused by the differences in temperatures, is what we call wind.

Heat from the Sun

The sun doesn't heat all the air on Earth the same. Rays are stronger at the Equator than in places where they strike Earth at different angles. For example, near the North and South Poles, the sun's rays are the most tilted and bring much less heat. Air is also warmer over land than over water.

Wind: Good and Bad

Changing temperatures, and the fact that Earth rotates on its axis, make our air unstable. What's a gentle breeze today—good for kite-flying—may turn into a tornado tomorrow—bad news for everyone!

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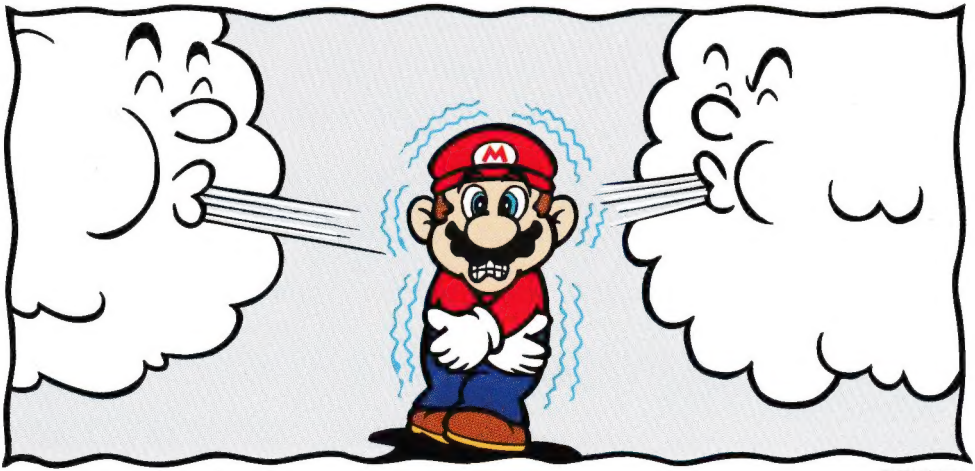
What's a front?

METEOROLOGY

1. A point where air masses of different temperatures meet
2. The arrival of rain
3. A sudden drop in temperature



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Fronts

Important exchanges of air take place in the atmosphere. At a point where two air masses of different temperatures meet, a front is created that is responsible for changing our weather.

1 A front is the line where air masses of different temperatures meet.

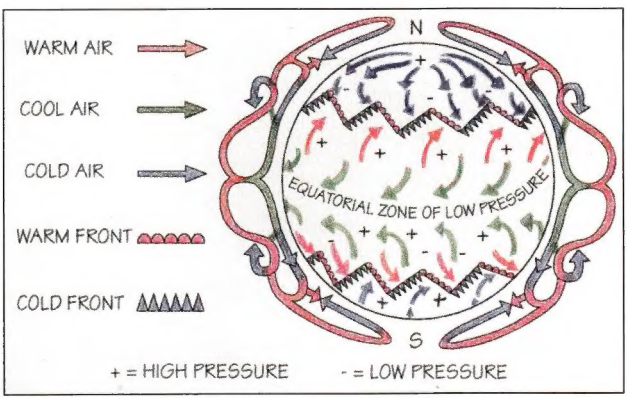

Illustration by Mimi Perrotti

Fronts are areas where two different air masses meet as they circulate around Earth.

Differences in temperature between Earth's poles and equator create an energy that causes air to circulate. Warm air over the equator rises and, once over the poles, displaces masses of cold polar air. That air in turn heads for the equator.

Air-to-Air Battles

As masses of air move forward or backward over Earth's surfaces they meet as a front. The most important is the polar front that separates masses of polar and tropical air. In winter, this front moves over the Mediterranean Sea, keeping winter weather north of the front line. In summer, the polar front moves up over Scandinavia. If you listen to your local TV or radio weather forecasters, you'll hear them report about fronts that may bring rain or snow, or heat or cold to your area.

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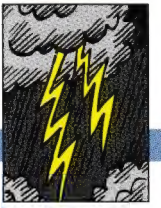
What's a jet stream?

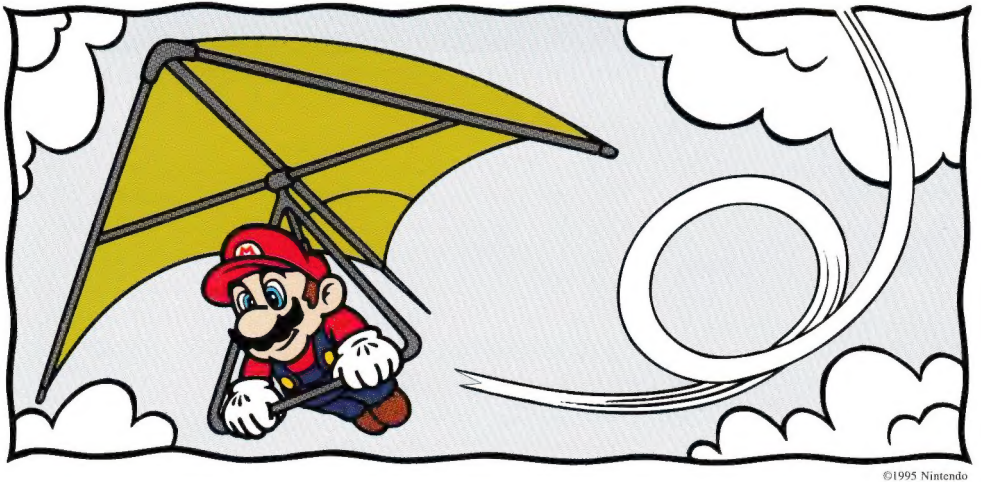


METEOROLOGY

1 A supersonic aircraft

2 Very strong wind at high altitude

3 A cyclone



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Jet Stream

A jet stream is a band of fast-moving, high-altitude air currents that flow like waves around Earth.

2 A jet stream is very strong wind at high altitude.

Photo © E. de Malglaive / Explorer

Today planes take advantage of a jet stream's tail wind to achieve greater speed.

There are three main jet streams 6-9 miles (10-15 km) above Earth. The polar and subtropical jet streams move from west to east; the equatorial jet stream moves east to west over Southeast Asia and Africa only, and only in the summer.

Moving On

Jet streams move horizontally and vertically, constantly changing position. The band of strongest winds is 60 miles (97 km) wide, about 3,000 miles (4,800 km) long, and moves 65-200 miles (105-320 km) per hour. Speed is higher in winter when there's a bigger temperature difference between warm and cold air masses.

Jet Stream Discovery

In World War II, pilots first flew planes higher than 29,500 feet (9,000 m). The pilots noticed that sometimes their speed fell from 347 miles (560 km) per hour to 149 miles (240 km) per hour. They had discovered and were flying against a jet stream!

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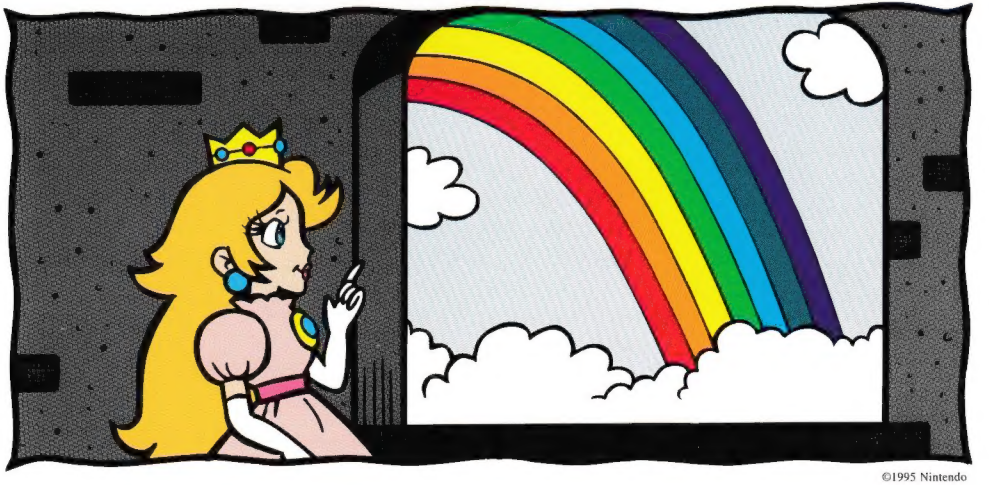
How many colors are in a rainbow?

METEOROLOGY

1 Six

2 Seven

3 Nine



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Rainbow

The order of the seven colors in a rainbow is always the same: red, orange, yellow, green, blue, indigo, violet.

2 There are seven colors in a rainbow.

Photo © Nacivet / Explorer

Through thick raindrops, the sun's rays may reflect twice and form a second rainbow above the first, with the colors in reverse order.

When it rains, the sun may pass behind a mist of raindrops. Suddenly, a rainbow appears in the sky opposite the sun. How did it happen?

White Light

Sunlight appears to be white, but it's actually made up of all the colors in the rainbow. When there's water in the air, like after it rains, the sun's rays bend to reveal these colors. Rays bend differently, according to the color—violet, the least bent, is on the inside of the bow. The seven colors in a rainbow blend together, so most people see only four or five. The higher the sun, the longer the bow—if the sun is near the horizon, someone on a mountain top might see an entire circle instead of an arc!

Hold a Rainbow

Want to hold a rainbow? Fill a pan with water and place it in direct sunlight. Position a mirror in the water, leaning against the side of the pan. Hold your hand in front of the mirror. A rainbow will be reflected right into the palm of your hand!

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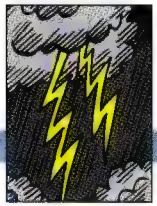
Why does it rain?



METEOROLOGY

1. Water vapor in the atmosphere cools and condenses.
2. The wind burst the clouds.
3. The clouds have too much nitrogen.

©1995 Nintendo

Rain

The water on Earth flows in a never-ending cycle of evaporation, condensation, and precipitation. Water that evaporates into the air condenses and falls to Earth once again as rain or snow.

1 When water vapor in the atmosphere cools and condenses, we get precipitation in the form of rain or snow.

Photo © E. Sampers / Explorer

Warm water vapor rises, cools, and condenses to form clouds. The water returns to Earth as rain or snow.

The water in Earth's oceans, rivers, lakes, and ponds is warmed by the sun. Some of the water evaporates into the atmosphere as water vapor, leaving behind all the dirt, salt, and minerals that were in it. As the warm water vapor rises, colder air condenses it, changing it back to water drops. The drops of water mix with dust in the air to form clouds.

Cloud Cover

Not all clouds bring rain. But large, thick cumulonimbus clouds and thick, sheetlike stratus clouds do. They look dark because they're made of many drops of water. The drops get so heavy they can no longer float in the air without falling. So down they fall, as some form of precipitation: rain, snow, hail, or sleet.

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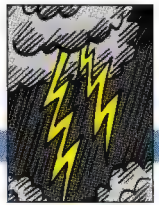
What is humidity?



METEOROLOGY

1. The number of people in a room
2. Shyness
3. Moisture in the air

©1995 Nintendo

Humidity

The atmosphere is full of water, even over hot deserts. Like a sponge, air absorbs evaporated water from oceans, lakes, rivers, and streams, and from green plants growing on Earth.

3 Humidity is the amount of moisture in the air.

Photo © F. Jalam / Explorer

Fog and mist limit visibility as water vapor hovers over the ground like a ghostly sheet.

The big factor in humidity is water vapor, an invisible gas in the air created by moisture soaked up through evaporation. As the water vapor rises, it cools and condenses around small bits of dust to form clouds, mist, fog, or early morning dew.

Early Morning Mist

At night, Earth cools little-by-little and cools the air above it. Humidity condenses and approaches saturation—the amount of water the air can hold at that temperature. (For example, the warmer the air, the more water vapor it can hold.) Fog and dew form over the ground, then disappear slowly as the sun rises and heats the air around Earth. Relative humidity is an expression you hear weather forecasters use in the form of a percentage. It compares the amount of water actually in the air with the amount of water the air could hold before becoming saturated.

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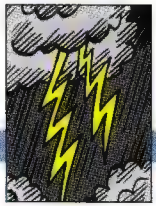
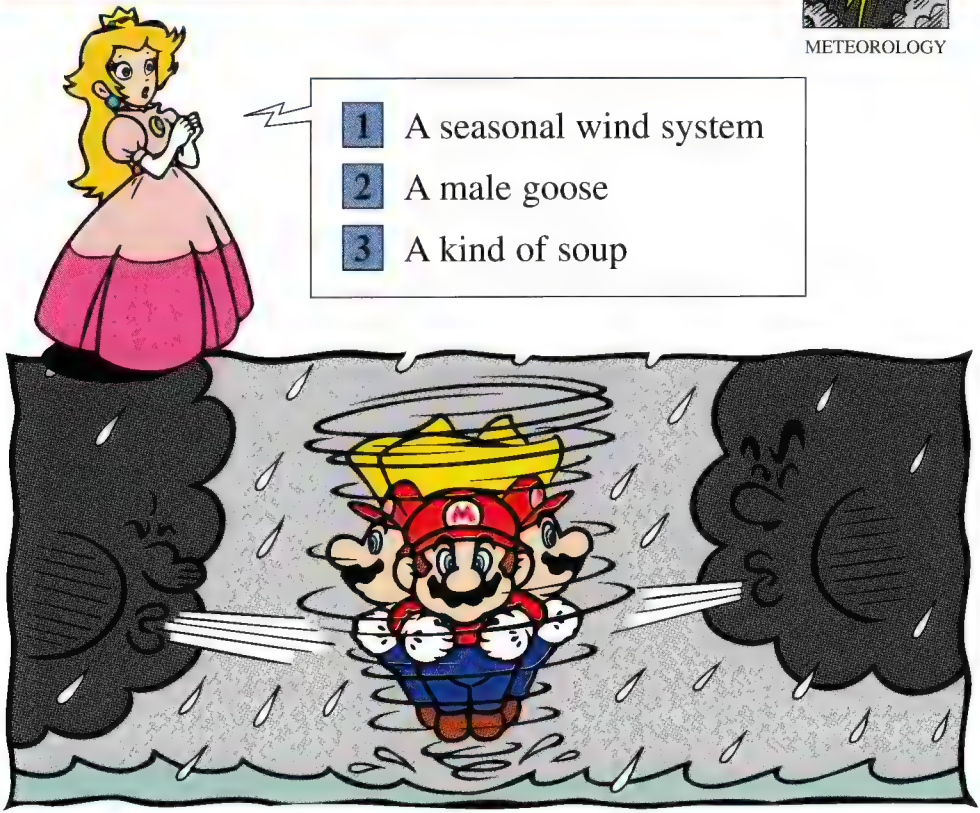
What is a monsoon?



METEOROLOGY



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Monsoon

A monsoon is a wind system in which the wind direction reverses with the season—from the sea over the continent in summer; from the continent over the sea in winter. The best-known monsoons are in Southeast Asia.

1 A monsoon is a seasonal wind system.

Photo © B. Maltaverne / Explorer

The best-known monsoons are in India. But these alternating seasonal winds also blow in other tropical regions, like northeastern Australia.

Summer Humidity

In summer, moist winds and accompanying hurricanes blow from the Indian Ocean. They come over areas in northwestern India that have very low pressure due to extreme heating of the land. The sky fills with clouds and torrential rain batters the mountains and valleys of India. The monsoon frequently causes flooding along the Ganges River of India and Bangladesh. But after six months of dry weather, local farmers look on the rain as a blessing. In some places they celebrate the rains—in China, monsoon rains are considered symbols of the dragon, the protector of the heavens.

Moistureless Winter

In winter, the monsoon phenomenon reverses. Cold dry winds sweep south from the high-pressure region of southern Siberia.

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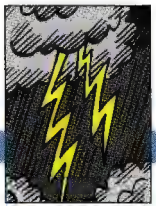
What's a tornado?



METEOROLOGY

1. A storm with 31-mile- (50-km-) per-hour winds
2. A storm with 62-mile- (100-km-) per-hour winds
3. A storm with 300 mile- (483-km-) per-hour winds

©1995 Nintendo

Tornado

A tornado, the most destructive storm, roars through an area in just a few minutes.

3 A tornado is a storm with winds of up to 300 miles (483 km) per hour.

Photo © Science Source / Explorer

A tornado moves at about 30 miles (48 km) per hour. Inside the funnel, swirling winds may reach more than 300 miles (483 km) per hour!

A tornado forms when a column of warm moist air rises in a powerful twisting motion in a thundercloud. Moving forward at an average speed of 30 miles (48 km) per hour, the violently rotating funnel of air, usually accompanied by a loud roar, lengthens and touches the ground. Winds in the twisting funnel toss animals, people, and furniture like a clumsy juggler. The funnel's vacuum can suck up cars, houses, or trees, then drop them. And when the sky clears, extensive property damage and personal injuries may be the result of this hit-and-run storm.

Stormy Seasons

The U.S. has more tornadoes than any other country, but these destructive storms can occur anywhere in the world except polar regions. And although "twisters" usually occur in spring and summer, they've been reported in every month of the year.

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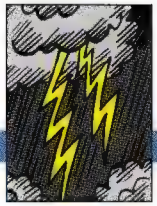
What is the atmosphere?



METEOROLOGY

1. A cloud of dust around the moon
2. Radiation from the sun
3. An envelope of gas surrounding Earth

©1995 Nintendo

Atmosphere

Atmosphere is a mass of gases that surround a planet or other heavenly body. Scientists divide Earth's atmosphere into four layers: the troposphere, the stratosphere, the mesosphere, and the thermosphere.

3 The atmosphere is an envelope of gas surrounding Earth.

Photo © J. P. Nacivet / Explorer

Clouds form in the troposphere. In this layer, most air masses meet to form weather fronts.

Earth's atmosphere surrounds and protects the planet. Without the atmosphere, we would freeze from the cold or burn up from the sun's rays.

Layers of Gas

The four layers of Earth's atmosphere are piled one on top of the other. The first layer, the troposphere, begins at Earth's surface and extends up 8-10 miles (13-16 km) over the equator and 5-6 miles (8-10 km) over the North and South poles—about the height of Mount Everest. Second is the stratosphere, extending about 18 miles (29 km) above Earth's surface—its upper level is a layer of ozone that protects us from the sun's ultraviolet rays. Next is the mesosphere, stretching 30-50 miles (48-80 km) above us. Then, beginning 50 miles (80 km) above Earth, is the thermosphere—its height is still unknown. Beyond it is outer space.

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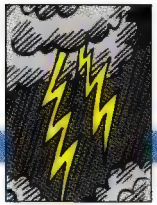
What protects us from the sun's ultraviolet rays?



METEOROLOGY

1. Radar
2. Carbon dioxide
3. Ozone

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Ozone

A layer of ozone around Earth protects us from the harmful effects of the sun's ultraviolet rays. But now this protective layer of gas is eroding and needs our help.

3 A layer of ozone protects us from the sun's ultraviolet rays.

© D. Maton / Explorer

In 1986, scientists first discovered a hole in the protective ozone layer. Many countries have banned the use of harmful chlorofluorocarbons to help maintain the ozone layer.

The ozone layer is being depleted by harmful gases, such as freon, used in refrigerators and air conditioners, and chlorofluorocarbons, used as propellants in some aerosol sprays. These gases, and others, slowly rise into the upper atmosphere, where sunlight breaks them up and destroys the ozone. Over time this has created holes in our protective blanket of ozone.

Ozone—Good and Bad

Ozone is a form of oxygen present in Earth's atmosphere in small amounts. In the upper atmosphere, it forms a protective barrier around Earth; but in the lower atmosphere it contributes to air pollution. Ozone near Earth mixes with car exhaust fumes and smoke from industrial areas to create air pollution that kills trees and plants.

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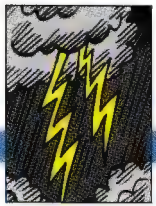
Which is not the name of a cloud formation?



METEOROLOGY

1. Cumulonimbus
2. Altobasso
3. Stratus

©1995 Nintendo

Clouds

In 1803, Englishman Luke Howard classified clouds into three groups, giving them Latin names: cirrus (curl), stratus (layer), and cumulus (heap). By combining the Latin words, clouds can be identified.

2 Altobasso is not the name of a cloud formation.

© P. LeFloc'h / Explorer

Watching the clouds helps you forecast the weather. Cumulonimbus and nimbostratus clouds indicate rain or snow.

Clouds are masses of dust and tiny water droplets, ice crystals, or both. Cirrus clouds are wispy. Cumulus are puffy, and stratus clouds are flat. When more than one cloud feature is present, meteorologists combine cloud names. So wispy, puffy clouds are called "cirrocumulus" clouds. The prefix nimbo and suffix nimbus signify rain or snow clouds. The prefix alto refers to clouds at high altitudes.

More Cloud Types

Cumulonimbus, or thunderheads, form giant mushroom shapes 20,000 feet (6,000 m) above the ground. If they bump, they set off an electrical charge of lightning that zigzags across the sky. Low nimbostratus clouds, below 3,500 feet (1,000 m), blot out the sun and usually mean continuous rain or snow. Cirrocumulus, small rounded tufts at 10,000-24,000 feet (3,000-7,500 m), signify a warm front.

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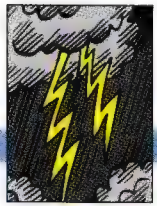
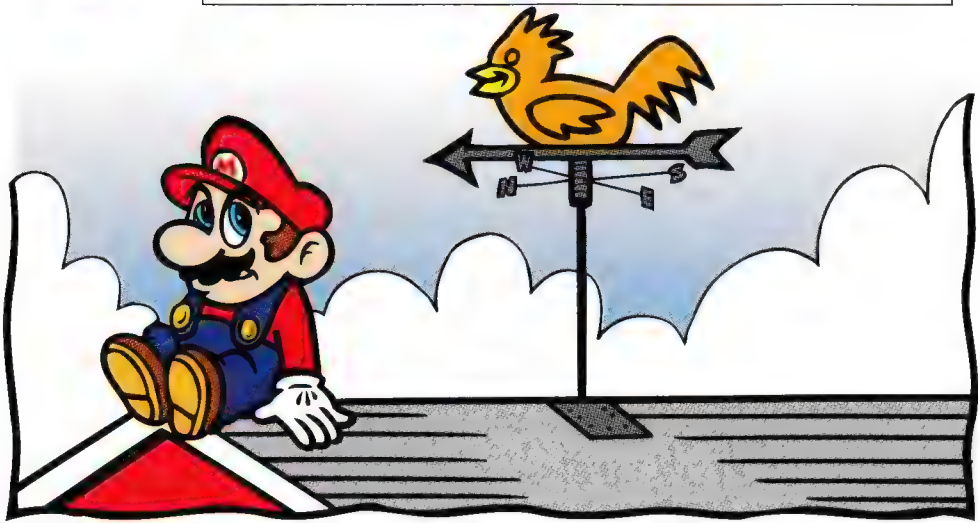
What is a weather vane?



METEOROLOGY

1. An instrument for measuring precipitation
2. An ancient wind-direction instrument
3. A compass that always points to the north



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Weather Vane

A weather vane, also known as a wind vane or weathercock, indicates the direction from which the wind is blowing.

2 A weather vane, the most ancient weather instrument, indicates wind direction.

© Superstock

Under the weather vane is a stationary part that indicates the four cardinal directions: north, south, east, and west.

A weather vane turns freely on an upright pole. The part that turns into the wind is generally arrow-shaped. The other end is wider, so it catches the slightest breeze. Air flow turns the arrow until the breeze can catch both sides of the wider end equally. Then, the arrow is pointing in the direction from which the wind is blowing.

Weather Watching

You can make a simple weather vane from heavy paper, a drinking straw, a pencil, and a straight pin. Cut a paper arrow shape and a wider shape for the back of the vane. Cut slits in the straw ends, then slide the shapes into the slits. Push a straight pin through the middle of the straw and down into a pencil eraser. Now go outside and hold the vane above your head to catch a breeze. The weather vane will point in the direction from which the wind is blowing.

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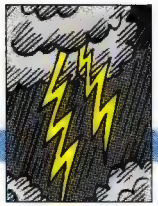
To which category do rain, snow, sleet, and hail belong?



METEOROLOGY

1. Palpitations
2. Prepositions
3. Precipitation

©1995 Nintendo

Precipitation

Water on Earth travels in a never-ending cycle of evaporation, condensation, and precipitation.

3 Rain, snow, sleet, and hail are forms of precipitation.

© F. Perrsuy / Sipa Press

Meteorologists measure amounts of precipitation with a rain gauge, a simple container with a ruler to measure depth.

Water evaporates, rises into the air where it cools and condenses to form clouds, then returns to Earth as precipitation: rain, snow, sleet, or hail. Precipitation is the vital fluid of life—the amount a region receives determines what can survive there. Too much rain can cause floods. Hail can ruin millions of dollars worth of crops. And heavy snow may result in avalanches.

Rain, Snow, or Sleet?

Clouds are made of water droplets, ice crystals, or both—except in tropical areas where the air is too warm for ice to form. Water droplets are attracted to the ice crystals, which grow and grow until they're so heavy they fall to Earth. If the air temperature between the cloud and Earth is below freezing, snow falls; if it's above freezing, the crystals melt and rain falls. If the crystals melt falling through warm air and then freeze in a layer of cold air near the ground, sleet falls.

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Where do cyclones occur?

METEOROLOGY

1 Anywhere except at the Equator

2 Only on the Equator

Illustration: Gary Fields

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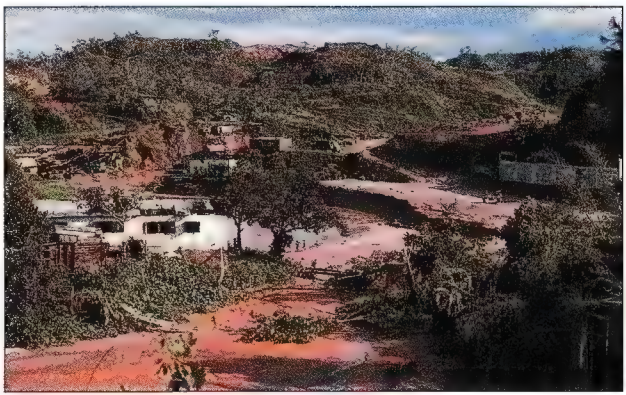
Cyclones

A cyclone is a system of winds that rotate around a center of low atmospheric pressure. North of the Equator, they rotate counterclockwise. South of the Equator they rotate clockwise.

1 Cyclones occur in the Northern and Southern Hemispheres, but not at the Equator.



© M. Marenthier / Hoa-Qui

When cyclones strike in tropical regions they bring heavy rains and powerful destructive winds.

Cyclones are huge, fast-moving storms that are dangerous and destructive. The swirling winds and fierce rain that accompany a cyclone can uproot trees, flip cars over, and tear the roofs off buildings. Cyclones in Caribbean and Atlantic Ocean regions are called hurricanes. In the Pacific, cyclones are called typhoons. Meteorologists divide cyclones into two types. Tropical cyclones develop near, but not at, the Equator in very warm regions. They measure about 60 to 310 miles (100-500 km) across and their wind velocity is nearly 200 feet (60 m) per second. Extratropical cyclones develop farther away from the Equator. They're much bigger than tropical cyclones, measuring 620 to 2,500 miles (1,000-4,000 km) across, but their wind velocity is about half that of a tropical cyclone. A cyclone usually destroys everything in its way.

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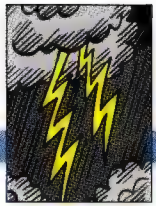
What is fog?



METEOROLOGY

1. Toxic fumes in the air
2. Condensed water vapor close to the ground
3. An unhealthy tadpole

Illustration: Gary Fields

©1995 Nintendo

Fog

Fog and clouds are condensed water vapor. So fog is really a cloud at ground level.

2 Fog is condensed water vapor close to the ground.

© Len Sirman

Fog is a cloud that forms close to the ground.

Fog forms from water evaporated from lakes, oceans, rivers, moist soil, and plants. Air can only hold so much water vapor at any given temperature—that's called its holding capacity. As the air temperature decreases, so does its holding capacity. The water vapor in the air changes to little water droplets that, together with bits of dust in the air, form a cloud. All of this takes place close to the ground. You may feel the water droplets in fog as it touches your face. The fog will disappear, or "burn off," when the temperature rises and the air's holding capacity increases.

Low Visibility

If the clouds are close together, the fog becomes so thick you "can't see your hand in front of your face." By international standards, fog is any condensation that reduces visibility to less than 3,281 feet (1 km). If the condensation doesn't greatly reduce visibility, it's called mist or haze.

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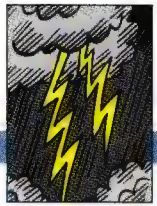
What causes lightning?



METEOROLOGY

1. Solar rays
2. Static electricity
3. Atomic isotopes

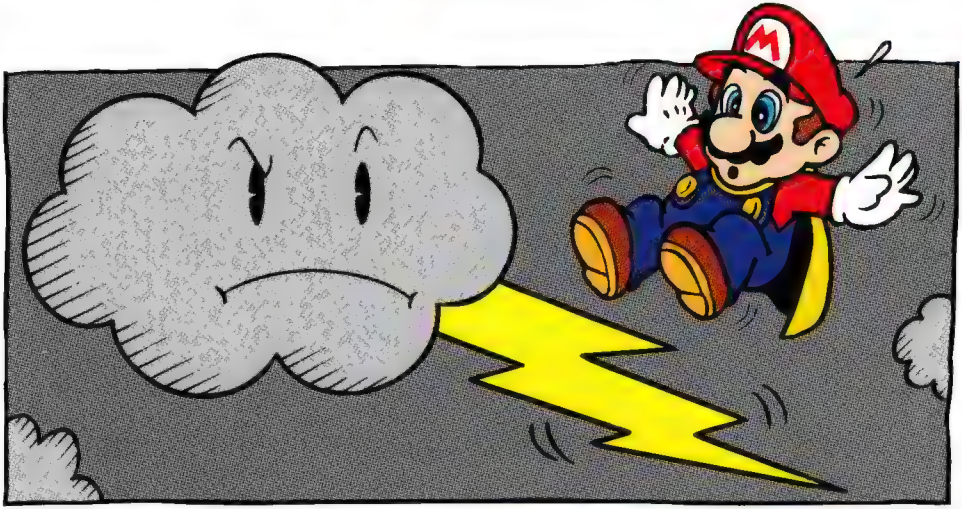


Illustration Gary Fields

©1995 Nintendo

Lightning

Clouds are charged with static electricity. It can jump, or discharge, inside the cloud, between two clouds, or to the ground as lightning.

2 Lightning is caused by static electricity in clouds.

© Len Sirman

Lightning generally hits the tallest thing in its path. If you're outside during an electrical storm, keep away from tall trees and stay low to the ground.

Sometimes when you remove a sweater you hear a crackling sound and see tiny sparks. That's static electricity. In the 1700s, Benjamin Franklin proved there's static electricity in heavy humid clouds.

Common Types

Sheet lightning occurs when static electricity jumps from one side of a cloud to another. Forked lightning occurs when the electrical charge shoots to the ground below, sometimes branching out to other clouds along the way. When this powerful electric charge touches ground it can cause fires and serious injury. Lightning bolts discharge about 100 million volts of electricity and heat the air to over 60,000° F (33,000° C). Sheet lightning flashes may be more than 90 miles (140 km) long; forked lightning bolts may be up to 9 miles (14 km) long.

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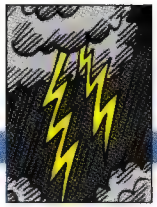
What is ball lightning?



METEOROLOGY

1. Lightning that bounces from the ground back up to a cloud
2. A glowing ball of electric current

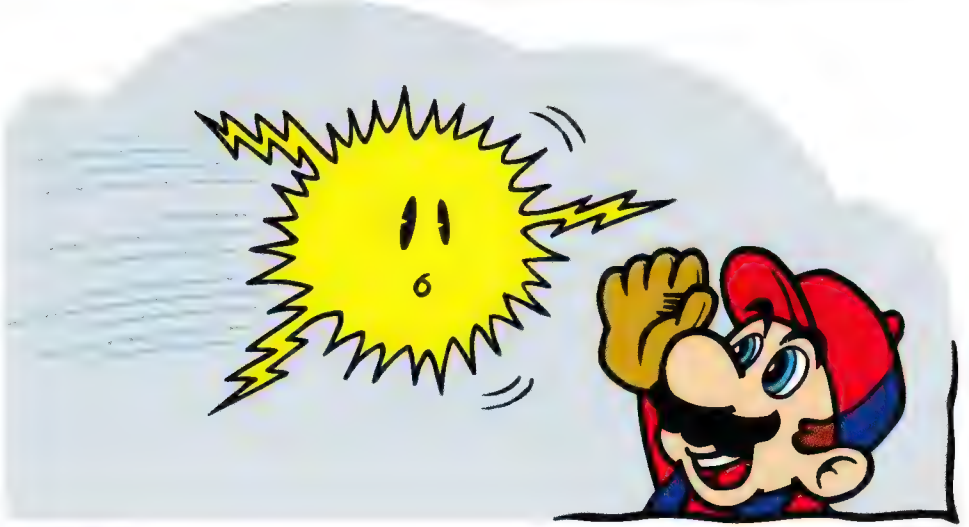


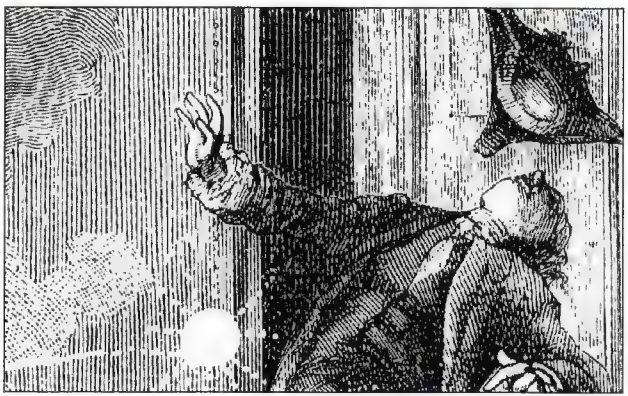
Illustration. Gary Fields

©1995 Nintendo

Ball Lightning

Ball lightning is described as a bright ball which floats in the air for a few seconds or minutes, then disappears. If it exists—and some scientists doubt it does—it's very rare.

2 Ball lightning is a glowing sphere or ball of electric current.



© D. R.

Ball lightning has been reported for years, but scientists have no proof it exists. If they could capture it on video tape, they could study it.

Ball lightning is usually reported just after ordinary forked lightning zigzags down toward Earth. Some witnesses say it's a red ball that floats down from a cloud, touches something on the ground, and explodes. Others describe it as a white ball rolling across the ground until it attaches to a good conductor of electricity, like a power line or a person. Some balls hiss or buzz, and they come in all sizes—from the size of a grapefruit to that of a beach ball.

Why No Explanation?

Scientists don't know a lot about ball lightning because they haven't been able to capture one on film to study. One theory is that it may be a tiny electrically-charged cloud created when a regular lightning bolt electrically charges moisture and dust in the air. But no one really knows for sure.

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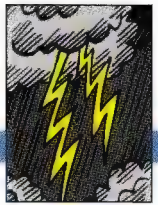
What is frost?



METEOROLOGY

1. A covering of tiny ice crystals
2. A type of plant
3. An icy fruit drink

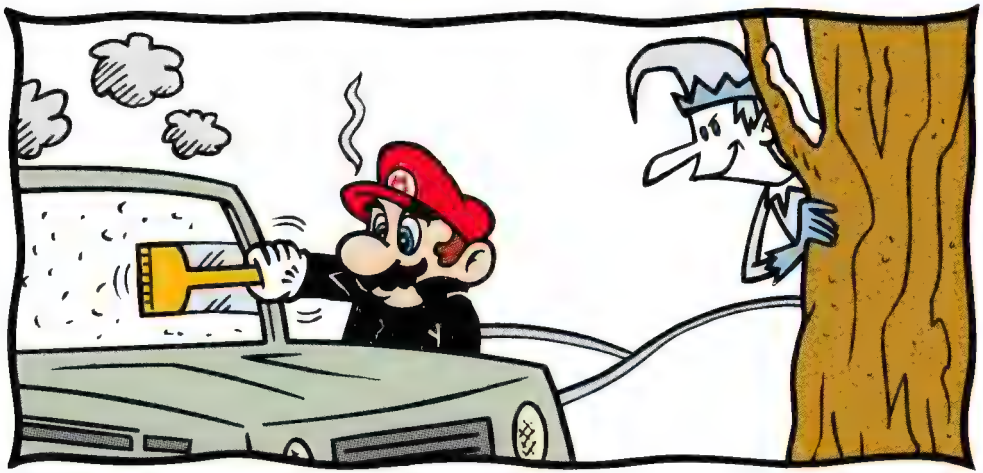


Illustration: Gary Fields

©1995 Nintendo

Frost

Frost usually forms on the ground and on exposed objects such as car windshields, house windows, mailboxes, trees, and plants.

1 **Frost is a covering of tiny ice crystals on a cold surface formed from the water vapor in the air.**

© Len Sirman

Frost sometimes forms beautiful designs on windows. They often disappear with the first sunlight.

When you go outside on a chilly morning and see the ground covered with a thin white film, you are looking at frost. Tiny ice crystals form because water vapor has frozen before it had a chance to become water. When the air is cool it cannot hold as much moisture as when it is warm, therefore the vapor condenses and freezes when the temperature reaches 30°F (0°C).

Black Frost

Besides white frost, there is also black frost which is practically invisible. Black frost occurs when the water inside plants freezes. When the water freezes it expands, killing plant cells and causing damage, sometimes even killing the plant. When the air warms, plants affected by black frost turn black. When it is very cold outside, black frost will penetrate the soil and can destroy underground crops such as potatoes and radishes.

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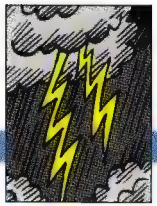
What is a meteorological dictum?



METEOROLOGY

1. A saying about the weather
2. A weather satellite probe
3. A disease caused by non-stop bad weather

Illustration Gary Fields

©1995 Nintendo

Meteorological Dictum

Over the ages people have come up with numerous little sayings, often poetic ones, to predict the weather. Some describe the movements of plants and animals, others the appearance of the sky and the style of the seasons.

1 A meteorological dictum is a saying regarding the weather.

© Len Sirman

They say that rain is near if frogs croak during the day, swallows fly low, and the scales on a pine cone close up.

It wasn't until the end of the 17th century that meteorological instruments were introduced, making weather prediction a science. Before that, people predicted the weather based on their interpretation of various signs from nature.

Ancient Signs

In 300 B.C., a Greek named Theophrastus wrote a book which contained over 200 weather predictions. Among these are the observations that "a red sunset announces good weather," and, "a halo surrounding the moon was a sign of rain." Other, more poetic sayings include, "March winds bring April showers, April showers bring May flowers," and "May comes in like a lion and goes out like a lamb." Modern studies claim that seven out of ten of the most popular dicta are, in fact, true.

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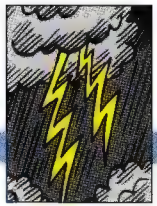
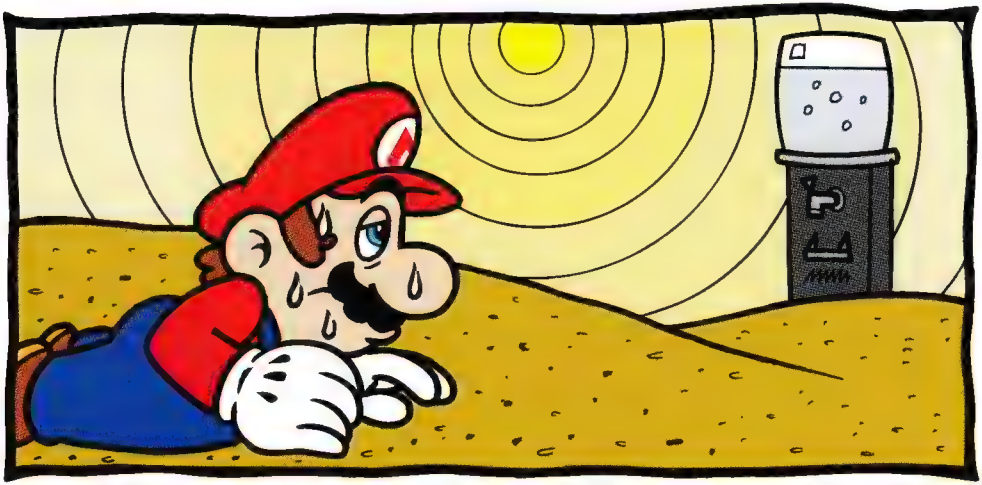
What is a mirage?



METEOROLOGY

1. An illusion involving refracted light
2. A union between two people
3. A garden tool



Illustration, Gary Fields

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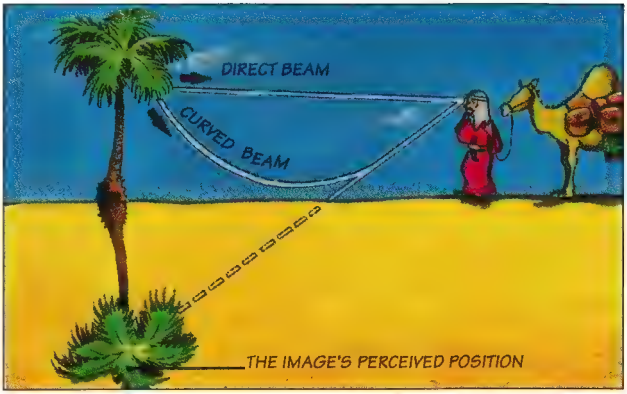
Mirages

Have you ever seen what looks like a puddle of water on a dry paved road? You might actually have seen an optical illusion known as a mirage.

1 A mirage is an illusion involving refracted light.



© Y Tabarès

As rays of light travel through layers of heated air, they are bent. This bending causes objects to appear distorted, as though they are being reflected in a circus mirror.

Mirages are produced when light passes through levels of air of different densities. Mirages usually occur in the desert or at sea. Heat radiating from a hot surface, such as sand, decreases the density of the surface air and forces a layer of denser, cooler air to remain above it. The hot surface air doesn't rise, as is usually the case, and rays of light passing through the layers of air are refracted. This results in the illusion of a film of water. The same thing happens on hot, paved roads. The greater the difference in the density of the air layers, the more light is refracted.

Mirages on Water

Mirages occur on surfaces of water where layers of denser air near the cool water exist below less dense air layers. The refraction of light through these layers makes objects look distorted, elongated, inverted, and suspended in the air. The illusion this produces is known as the looming effect.

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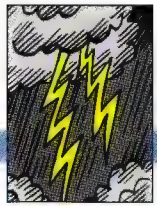
What causes wind?



METEOROLOGY

1. Differences in temperature and pressure
2. Storms and blizzards
3. Earth's gravity

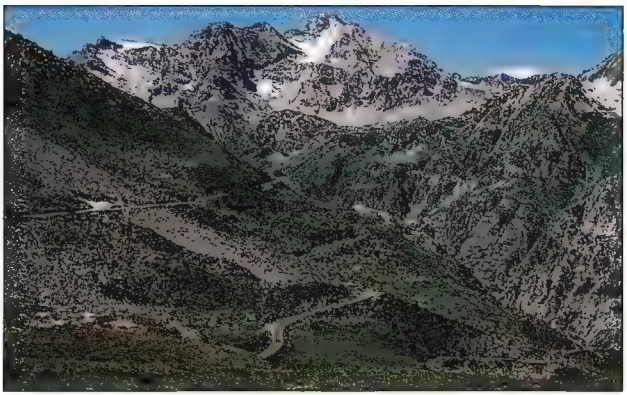
Illustration, Gary Fields

©1996 Nintendo

Wind

Wind is air set in motion by temperature and pressure imbalances in Earth's atmosphere.

1 Wind is caused by variations in air temperature and pressure.



© E. Valentin / Hoaqui

Land contour is an important factor in wind distribution. Some mountainsides are completely sheltered from the wind, while mountain passes are real wind tunnels.

All winds blow both horizontally and vertically. Because the horizontal components of wind are so much greater than the vertical components, the term "wind" commonly designates only horizontal air movement. Wind is Earth's way of seeking balance in air pressure and temperature. Steady winds carry heat from the Earth's equator toward the North and South Poles.

Like Water

Wind may be compared to water in its ability to erode, carry, and deposit sediments. Air is much less dense and can only carry very light particles. For this reason, wind erosion is most pronounced in arid regions, such as deserts, where fine sand and other sediments are not firmly held in place by plants or ground moisture.

Throughout history, wind energy has been harnessed for use in farming and industry. Windmills capture energy directly from the wind; wind energy is also extracted indirectly from ocean waves.

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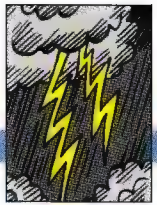
Does the weather affect the behavior of animals?



METEOROLOGY

1. Yes, the weather affects the behavior of animals.
2. No, the weather does not affect the behavior of animals.

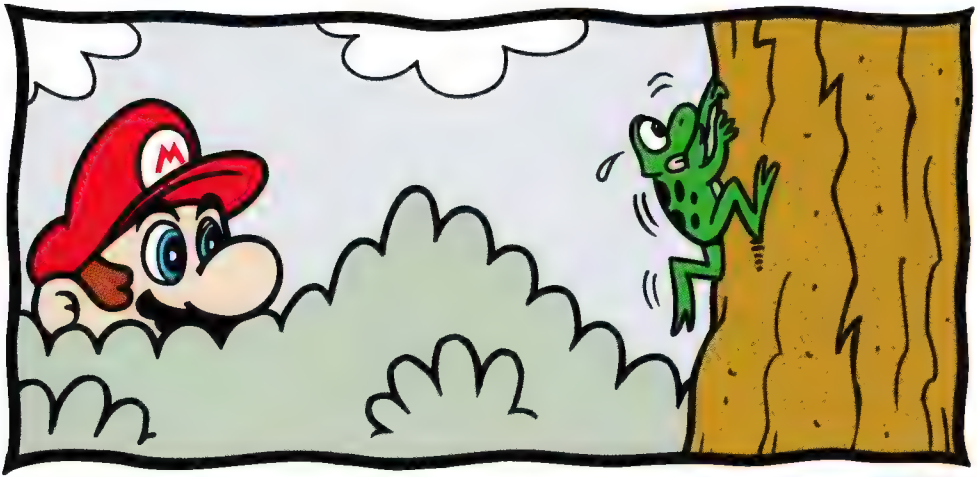


Illustration: Gary Fields

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Animal Behavior

Hibernation and migration are two ways animals are affected by weather. Animals reactions to the world around them have long been used as a means to predict the weather.

1 Yes, the weather affects the behavior of animals.

© Sunset

Many believe that if a ladybug walks to the end of your finger and flies off, the sun will shine. If it stays on your finger, it will rain.

Many people believe that animal behavior is influenced by atmospheric changes. Although there is no scientific proof that animals are affected by changes in the weather, many popular superstitions in all cultures put animals in the role of weather forecasters.

Animal Barometers

Many believe that if frogs are heard croaking at night, the sun will shine the following day. The same prediction holds if frogs are seen climbing tree trunks. To test the theory, an Austrian scientist observed ten frogs for forty-eight days. During this time there were nineteen days of rain, but the frogs had announced sunshine twelve times. Maybe bees are more reliable. Some people say if bees stay in their hives, rain is on its way. The same goes for chickens rolling in the dust, low-flying swallows, and moles making mounds.

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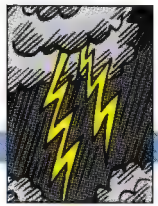
Where was the hottest air temperature recorded on Earth?



METEOROLOGY

1. Ecuador
2. The South Pole
3. Libya

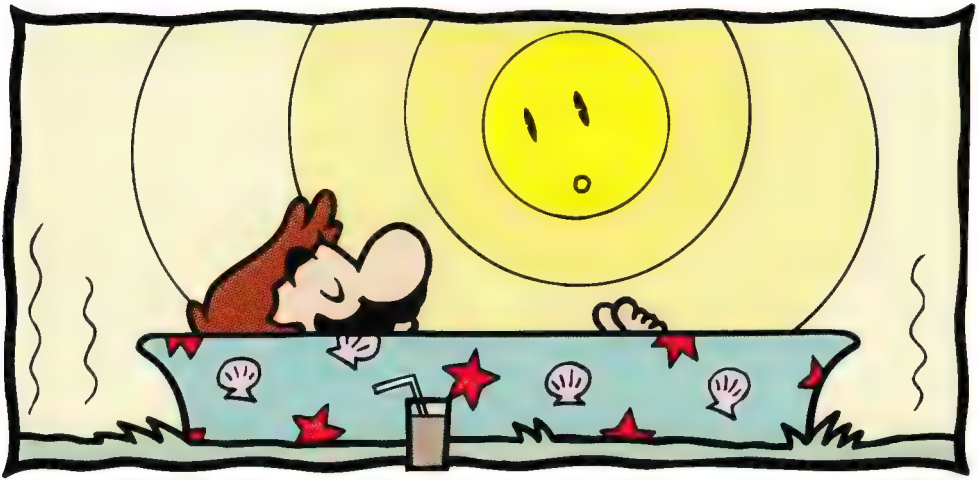


Illustration: Gary Fields

©1996 Nintendo

Climate

When we talk about places on earth being hot or cold, we are talking about climate. In a general way all climate is determined by the heat of the sun.

3 **The world's record heat was recorded in 1922 at a place called Azizia in Libya; it was 136.4°F (58°C)!**

© J.-L. Bohn / Explorer

The coldest temperature was recorded at the South Pole in 1958. It was -134.86°F!

Because the surface of the earth is curved, the heating effect of the sun is greatest at the equator and least at the North Pole and the South Pole. The Sahara Desert is located along the equator in Africa. In July, the sun is so strong in many places in the Sahara Desert that the average temperature is 100°F (37.8°C) during the day. When the sun goes down, however, the land cools very quickly. The temperature may drop 30 to 50 degrees, and in some oases in winter, there is even frost at night!

Other Factors

There are many other factors that help to determine climate. The most important ones are water, land, and altitude. The waters of the oceans, the existence of large land areas, and the altitude of the land can all combine to create different climates regardless of their location on Earth.

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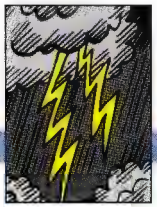
Is there water in Earth's atmosphere?



METEOROLOGY

1. No, the atmosphere contains only rare gases.
2. Yes, the atmosphere contains a large amount of water.

Illustration: Gary Fields

©1996 Nintendo

Water

The atmosphere is composed largely of hydrogen and nitrogen gases. It also contains carbon gas and water either as a gas called water vapor, as a liquid, or as solid ice.

2 Yes, water is one of the main components in Earth's atmosphere.

© Chandelle / Jerrican

There are over 100 different kinds of clouds. You may notice more than one kind in the sky at one time.

Water changes from one form to another with variations in temperature.

Composed of water droplets or ice crystals, clouds are formed when water vapor cools and condenses in the atmosphere above Earth's surface. Clouds distribute water as hail, sleet, snow, and rain. They also filter out some of the sun's rays.

Cloud Types

Clouds are grouped into four main categories, depending on their distance from the ground. Feathery, threadlike cirrus clouds travel at 5 miles (8 km) or more above Earth's surface. Thick, fleecy altocumulus clouds float 2 to 4 miles (3 to 6 km) above Earth. Stratocumulus clouds float at heights of 1 mile (1.6 km). Cumulonimbus clouds travel at heights of 1 to 8 miles (1.6 to 13 km) and usually bring sudden, heavy rains.

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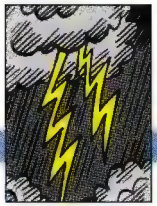
When is frost formed?



METEOROLOGY

1. In cold and dry weather
2. In cold and humid weather
3. Only in the morning

Illustration: Gary Fields

©1996 Nintendo

Frost

In fall or winter, you may awaken to find the trees and grass covered with frost. Frost is formed when water vapor in the air turns to ice without going through a liquid phase.

1 Frost forms when the weather is cold and dry.

© R. Cundy / Explorer

Frost delicately outlines leaves and branches on some fall and winter mornings.

Frost is a thin layer of ice which forms when water vapor in the air condenses on a surface whose temperature is below freezing, or 32°F (0°C). On warmer surfaces, water vapor condenses into tiny liquid droplets called dew.

Frost and Agriculture

Frost forms on objects that do not generate heat, including grass, wood, metal, and glass. Since frost can kill plants, farmers try to plant, raise, and harvest their crops after the last frost of spring and before the first frost of fall. In some regions, this period is so short that farmers can only plant one crop. In other areas, a long growing season allows more than one planting. Citrus fruits—oranges, limes, grapefruit, tangerines, and lemons—are especially sensitive to frost. Citrus cultivators have methods to protect their plants from the few heavy frosts that occur in their areas.

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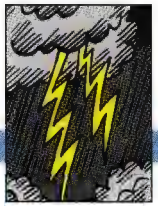
What is the Coriolis force?



METEOROLOGY

1. Wind deflection caused by Earth's rotation
2. Water pressure in lakes and oceans
3. Gravity exerted on Earth by the moon

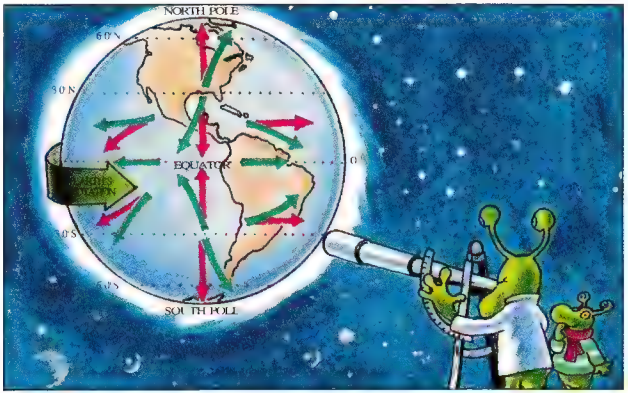
Illustration Gary Fields

©1996 Nintendo

Coriolis Force

Described in 1835 by French physicist Gustave-Gaspard Coriolis, the Coriolis force is measured based on an object's speed of motion, the velocity of Earth's rotation, and latitude.

1 The Coriolis force is the deflection of wind or any other body moving above Earth's surface caused by Earth's rotation.



The Coriolis force is strongest at Earth's poles and weakest at the equator.

The Coriolis force causes wind to shift in a clockwise direction around areas of high pressure and in a counterclockwise direction around areas of low pressure in the northern hemisphere. These directions are reversed in the southern hemisphere. The air in wind does not really change direction. It only appears to because of Earth's rotation.

The same phenomenon causes water to flow down the drain in a clockwise direction in the northern hemisphere and in a counterclockwise direction in the southern hemisphere.

Applications

Meteorologists use the Coriolis force to predict the path of prevailing winds and storm fronts. Oceanographers use it to predict the rotation of ocean currents. The phenomenon is also important in ballistics, the study of projectiles in flight. The Coriolis force affects the launching and flight path of missiles, rockets, and other space vehicles.

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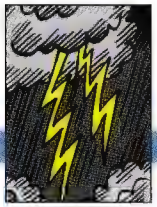
What causes dust storms?



METEOROLOGY

1. Heavy rains in the desert
2. Low pressure and high temperatures
3. Freezing temperatures and slick surfaces

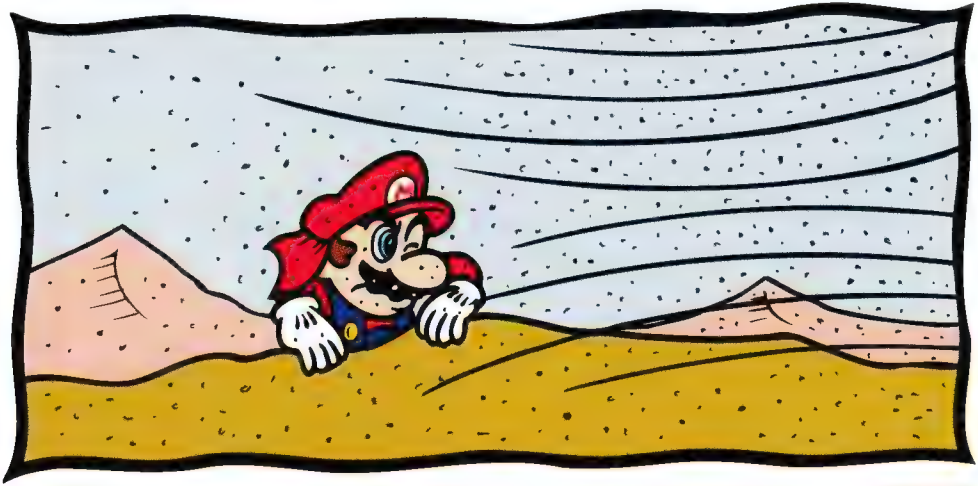


Illustration: Gary Fields

©1996 Nintendo

Dust Storm

In a dust storm, strong winds sweep up billions of grains of sand and dirt into terrible clouds that envelop everything in sight. Dust storms stop as suddenly as they start.

2 Dust storms occur when pressure drops and the ground temperature is high.

© Verbeeck / Explorer

Sudden and often violent, dust storms can be very dangerous to animals and people.

Dust storms occur when heated air near the surface of the ground rises rapidly to heights of more than 6 miles (10 km). Cooler air rushes in underneath and travels rapidly over the ground, sweeping up fine sand and soil particles and carrying them at very high speeds.

Effects

Dust storms may deposit enormous amounts of silt in some areas but strip the ground of topsoil in others. Although dust storms occur most often in the desert, the infamous Dust Bowl of the 1930s ruined the topsoil in large, drought-ridden areas of Texas, Oklahoma, Colorado, and New Mexico. Twenty years later, almost identical conditions destroyed newly developed farmland in Kazakhstan, then a part of the Soviet Union.

Today, meteorologists can predict dust storms using satellite photographs and records of rainfall.

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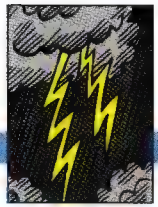
What do we call a violent snowstorm?



METEOROLOGY

1. Tornado
2. Tsunami
3. Blizzard

Illustration: Gary Fields

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Blizzards

Ice and snow and winds that blow…it could be a blizzard! An ordinary snowfall is cold and wet and can last for hours, but it takes severe wind to make a blizzard.

3 A violent snowstorm is called a blizzard.

© Parer-Cook / Auscape / Explorer

Arctic explorers frequently have to endure blizzard conditions as they travel across icy polar regions.

The National Weather Service issues a blizzard warning when winds of 35 miles per hour (56 km/h) or more are combined with heavy snow for at least three hours. It's not uncommon for a blizzard to dump several feet (m) of snow in a region. High winds cause the snow to drift, or pile up, so that it covers bushes, cars, and even small buildings. In cold-weather states like Alaska and Minnesota, blizzards can occur several times in a winter. The best thing to do during a blizzard is stay indoors. High winds and heavy snowfall limit visibility and make driving, or even walking, dangerous.

Appropriate Name

According to one story, the word "blizzard" was first used to describe a violent snowstorm in 1870 by a newspaper editor in Iowa. Originally, the word had been used to describe a volley of shots. It seemed appropriate since snow in a blizzard does seem to attack like a spray of gunfire.

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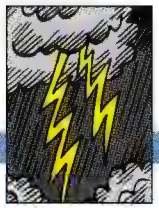
What instrument measures changes in atmospheric pressure?



METEOROLOGY

1. Atmometer
2. Barometer
3. Pressometer

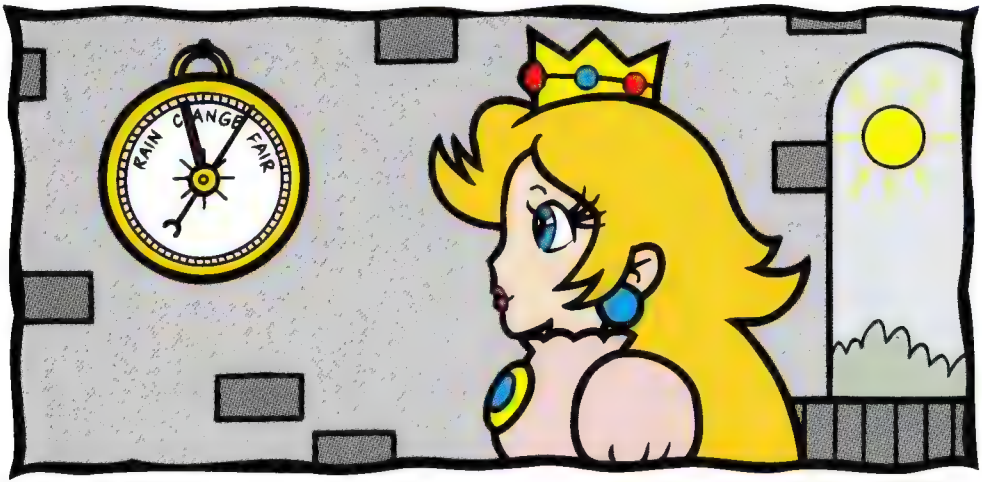


Illustration: Gary Fields

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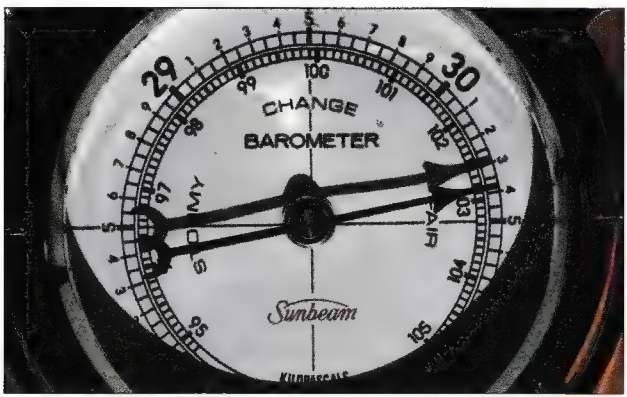
Barometer

Changes in atmospheric pressure signal changes in weather. Barometers, which measure pressure changes, help meteorologists forecast the weather.

2 A barometer is the instrument used to measure changes in atmospheric pressure.



© Jeff J. Daly, Visuals Unlimited

A barometer indicates atmospheric pressure. A change in that pressure indicates that a change in the weather is occurring.

We don't usually sense it, but air has weight. Air in Earth's atmosphere actually presses down on the planet. This is called air pressure.

Weather Watch

Weather activity can make air pressure change. The first signal that sunny, fair weather is on the way is a rise in air pressure. Stormy weather is usually preceded by low pressure areas—the more severe the storm, the lower the air pressure. By using a barometer to measure air pressure, meteorologists can anticipate weather changes.

Italian Invention

The barometer was invented in 1643 by Italian physicist Evangelista Torricelli. The first barometers were glass tubes filled with mercury that rose and fell with pressure changes. They're accurate, but fragile. Aneroid barometers consist of an airtight box with flexible sides that move with pressure changes. They're less accurate, but easier to use.

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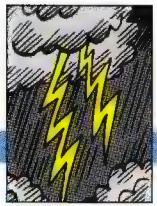
When were the first weather stations created?



METEOROLOGY

1. 1763
2. 1855
3. 1976

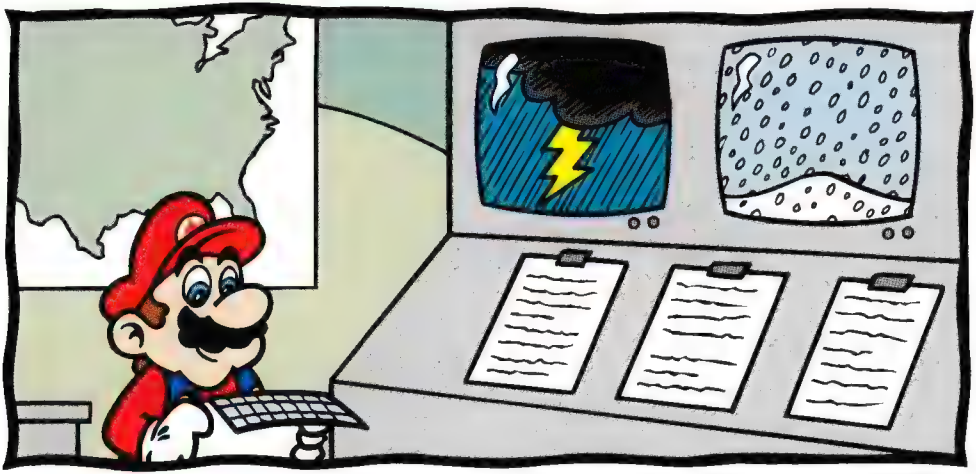


Illustration: Gary Fields

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Weather Stations

Most weather stations are at airports near cities, but some are in remote locations like Antarctica near the South Pole.

2 **The first weather stations were created in France, by order of Napoleon III, in 1855.**

© P. Roy / Explorer

Weather stations use barometers, thermometers, and other instruments to measure surface weather conditions. They also follow conditions from above ground and from space.

Many weather stations in the U.S. are run by the National Oceanic and Atmospheric Administration (NOAA), a federal agency which supervises the National Weather Service.

The Science of Weather

The primary job of weather stations is weather forecasting. Meteorologists observe weather conditions on Earth's surface, above ground, and from space to forecast, or predict, how they will change in the near future. Surface observations measure factors like air pressure, temperature, and wind speed. Weather balloons floating in Earth's atmosphere, take similar measurements from as high as 100,000 feet (30 km) above ground. Radar tracks precipitation over distances of about 250 miles (400 km), to follow storms as they move toward or away from a given area. Photos from satellites 22,000 miles (36,000 km) in space show a "big picture" of weather systems as they move across Earth.

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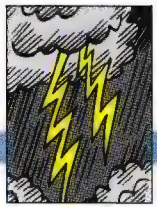
When did meteorology become a science?



METEOROLOGY

1. 17th century
2. 18th century
3. 19th century

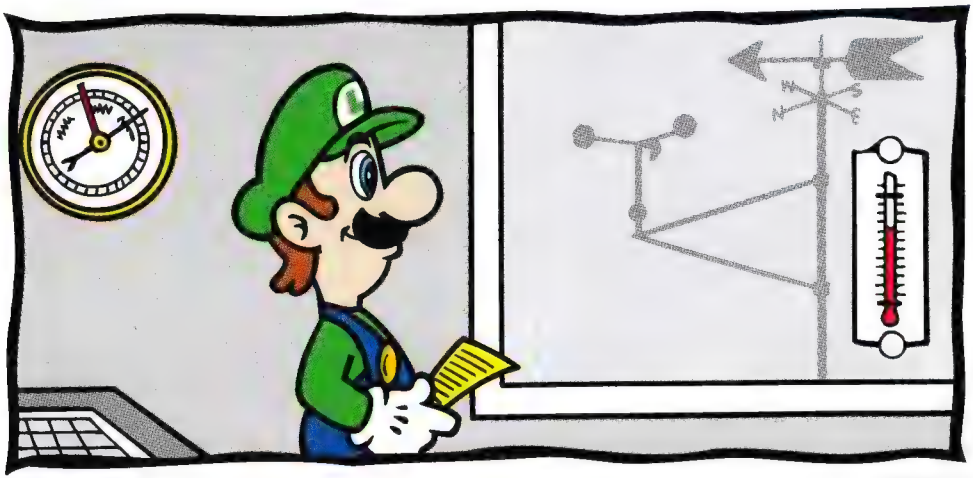


Illustration Gary Fields

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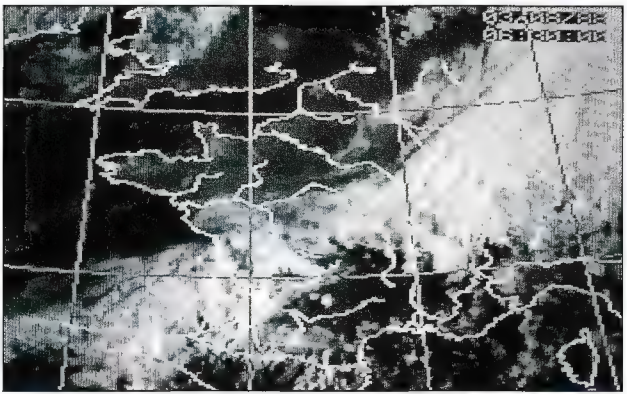
Meteorology

The invention of the barometer by Italian physicist Evangelista Torricelli in 1643 is considered the start of modern meteorology.

1 Meteorology became a science in the 17th century.



© Berenguer / Jerrican

Satellite weather photographs show cloud systems over large expanses of land. Meteorologists use these photos to follow the paths of storms.

To chart and analyze the weather, scientists needed accurate ways to measure weather components—temperature, wind speed, and air pressure. The barometer, which measures changes in air pressure, was the first scientific weather instrument. Soon after, Grand Duke Ferdinand II of Italy created the first modern thermometer. Later, he developed the hygrometer, which measures water content in the air. In 1644, English physicist Robert Hooke invented the anemometer, which measures wind speed. These are still used by weather stations today.

View From Space

Modern technology brought more inventions. In the 1960s, the U.S. launched a group of TIROS satellites (Television Infrared Observation Satellite) to observe Earth's weather patterns from space. In 1964, the program was upgraded with Nimbus satellites that could transmit photos day and night. Weather satellites are now regular tools used by modern meteorologists.

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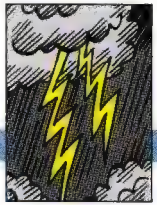
What causes the formation of clouds?



METEOROLOGY

1. Condensation of humidity in the air
2. Changes in air temperature
3. The wind

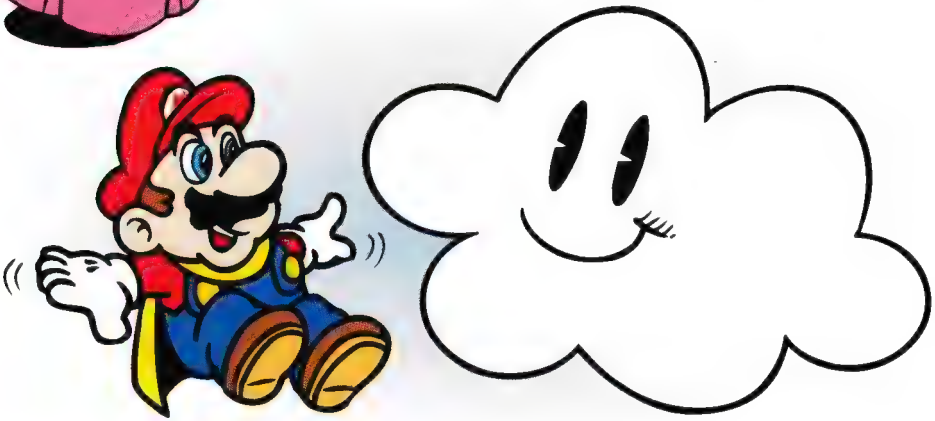


Illustration: Gary Fields

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Cloud Formation

A cloud is a mass, or collection of tiny water droplets or ice crystals created by water vapor in the air.

1 Clouds are formed by condensation of humidity, or moisture, in the air.

© Floy / Explorer

Observation of clouds is important to the science of meteorology. Meteorologists study the shape, altitude, and motion of clouds.

Air naturally contains water vapor, which it draws up from bodies of water and from Earth's surface. When air is warm, it can hold a lot of moisture. Cold air holds less.

As air cools, water vapor condenses, or masses together. In the process, the invisible gaseous vapor turns into tiny droplets of liquid water or solid crystals of ice. These masses of water droplets and ice form the clouds we see.

Completing the Cycle

Believe it or not, we couldn't have clouds without salt or dust in the air. Tiny particles of dust and salt attract the water vapor which condenses around them. When the water becomes too heavy for the particles to hold, it falls to Earth as precipitation—rain or snow. The precipitation replenishes the moisture that the air draws up from Earth and the oceans, so the cycle can begin again.

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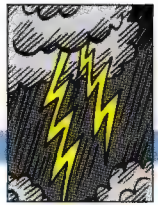
What is an equinox?



METEOROLOGY

1. A day with equal hours of sunlight and darkness
2. A diet for horses
3. An eight-sided geometric figure

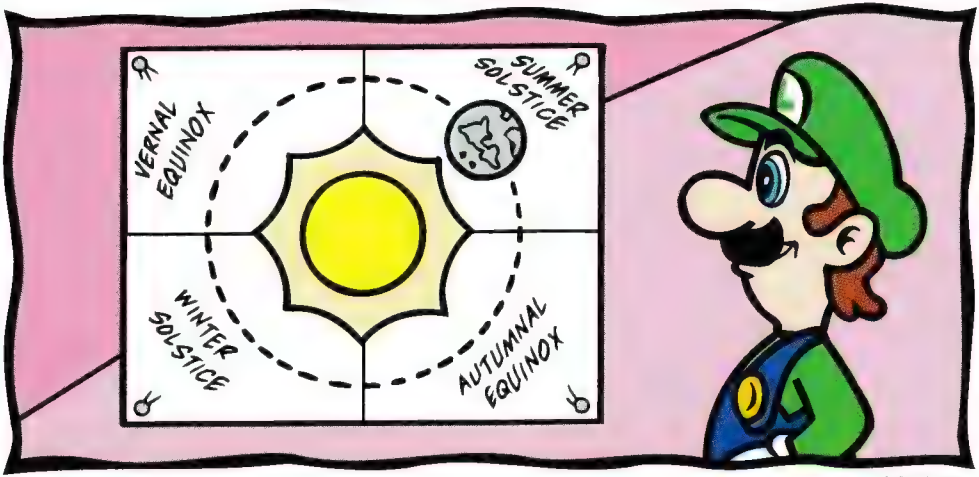


Illustration: Gary Fields

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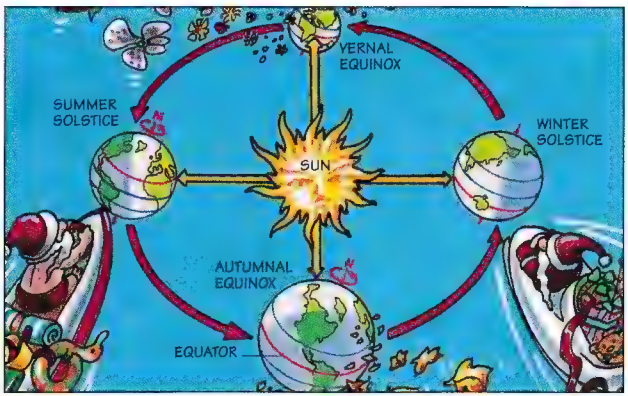
Equinox

Equinoxes mark the start of spring and fall. The vernal, or spring, equinox occurs March 21; the autumnal equinox, September 21.

1 An equinox is a day with almost equal hours of sunlight and darkness.



© Y Tabanés

In the northern hemisphere, spring starts in March, summer in June, fall in September, and winter in December. In the southern hemisphere the seasons are reversed, so in Australia people celebrate Christmas in the summer!

Earth is slightly tilted in relation to the Sun. As Earth revolves around the Sun there are times of the year when the North Pole is closer to the Sun than the South Pole is, and times when the South Pole is closer than the North Pole. In the northern hemisphere, summer starts on the day the North Pole is closest to the Sun—June 20 or 21. This is called the summer solstice; it's the longest day of the year. The day the North Pole is farthest from the Sun—December 20 or 21—is the winter solstice, the shortest day of the year. In Earth's southern hemisphere seasons and solstices are reversed. Winter starts in June and summer in December. The days exactly in between the two solstices, March 21 and September 21, are the equinoxes. Equinox comes from the Latin words meaning "equal" and "night." On these days, the hours of daylight and night are equal.

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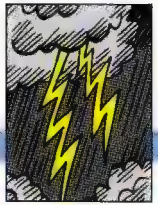
Can people create rain?



METEOROLOGY

1 Yes, atmospheric scientists can create artificial rain.

2 No, rain can only occur naturally.

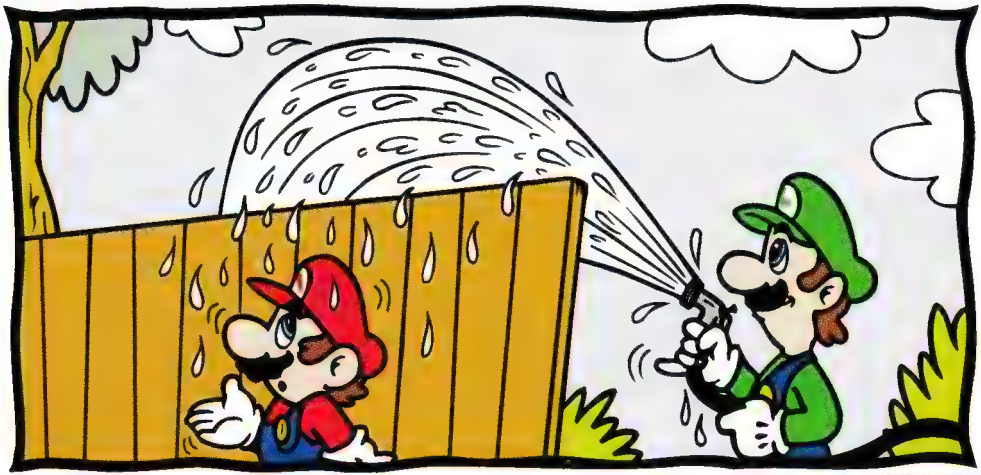


Illustration: Gary Fields

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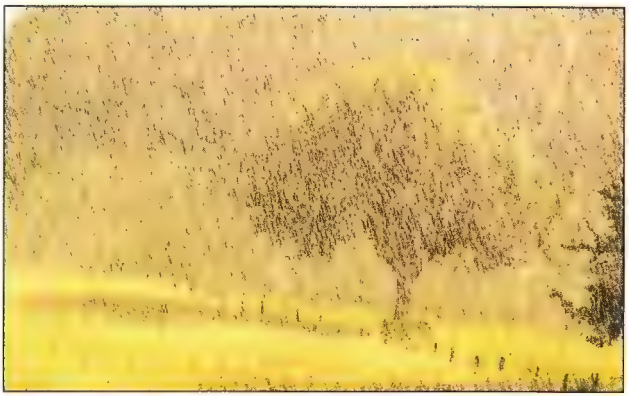
Cloud Seeding

The creation of artificial rain can help farmers fight drought conditions.

1 **By "seeding" clouds, atmospheric scientists can force them to produce rain.**



© J. Bouchayer / Diaf

Seeding clouds can increase rainfall by about 10%, but the results are unpredictable. Today cloud seeding is done occasionally, especially in regions with dry climates.

Rain forms when particles of dust, smoke, or salt are blown up into the clouds. High in the atmosphere where temperatures are low, these particles freeze and the moist air in the clouds condenses around them. The particles are called condensation nuclei because each one is the nucleus, or center, around which the condensation forms. With layer upon layer of water clinging to the condensation nuclei they become heavier and heavier. When they're too heavy to float on the warm air that keeps clouds aloft, the droplets fall to Earth as rain.

Seeding the Clouds

Long periods without rain can ruin crops and harm animals. If clouds don't produce enough rain on their own, atmospheric scientists can give them help by seeding them with condensation nuclei. Clouds can be seeded with dry ice crystals dropped from above by airplanes. Or they can be seeded with silver iodide smoke released from the ground and carried into the clouds by the wind.

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What is the eye of a storm?

METEOROLOGY

1. The part that determines its direction
2. An area of calm at the center of a hurricane
3. The part with the most violent winds

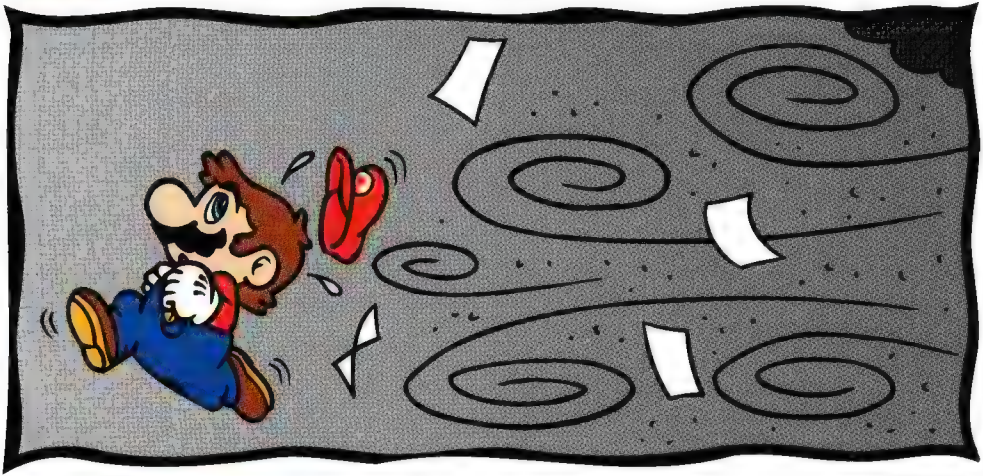

Illustration: Gary Fields

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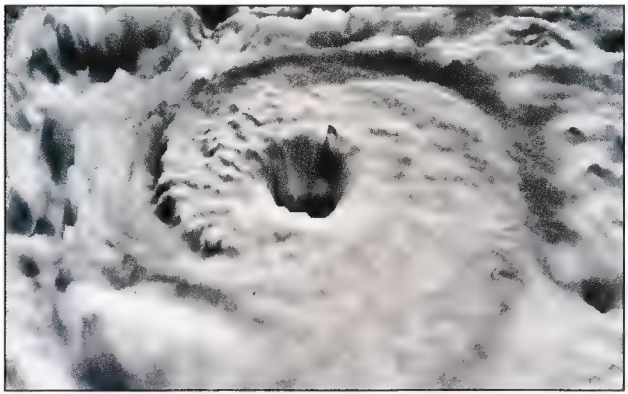
Eye of a Storm

In the middle of the violent swirling winds of a hurricane is an area of calm warm air. This is called the eye of the storm.

Hurricanes begin life as storms at sea when normal wind patterns over tropical waters are disturbed by air pressure changes in the upper atmosphere. Clouds and thunderstorms form, and winds gather speed. Meteorologists classify these storms based on the speed of their winds. When the winds are between 39 and 73 miles per hour (63-117 km/h) it's called a tropical storm. When winds reach 74 miles per hour (119 km/h) or more, the storm is a hurricane.

2 **The eye of a hurricane is an area of calm at the center of the storm.**



© Len Strman

Huge bands of clouds and wind spiral around the outside of a hurricane, but at the center is an area of calm—the eye of the storm.

Mile-High Clouds

Funnel-shaped hurricanes stretch from sea level 7 to 9 miles (12-15 km) into the air, and may be as much as 600 miles (966 km) in diameter. At the base, winds flow into the storm. They spiral around the center of the storm and flow out at the top. Inside the storm a cylinder-shaped cloud wall forms. Violent winds churn outside it, but within the cloud wall is the eye of the storm, where the air remains warm and calm.

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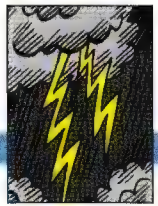
Where did the largest hailstones in the U.S. fall?



METEOROLOGY

1. Coffeyville, Kansas
2. Galveston, Texas
3. Xenia, Ohio

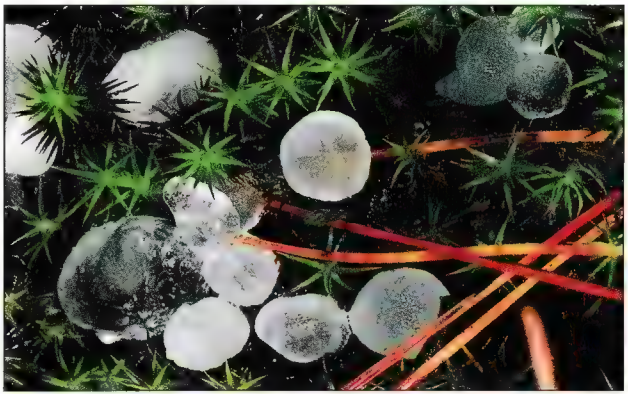
Illustration: Gary Fields

©1996 Nintendo

Hail

The average hailstone is about 1/4 inch (.63 cm) in diameter. Hail that fell in Coffeyville measured 5.57 inches (14.1 cm) in diameter and weighed 1.67 pounds (.75 kg).

1 **The largest hailstones recorded in the U.S. fell in Coffeyville, Kansas, in 1970.**



© Animals Animals / Sunset

To be officially considered hail, a stone must be at least 1/5 inch (5 mm) in diameter. Golf ball-size hail and even hail as large as baseballs is not uncommon.

Hail is one of Earth's more unusual weather conditions. Basically, hail is precipitation in the form of ice. What makes it odd is that icy hail usually falls in the summertime!

Cloud Activity

Hail forms in cumulonimbus, or thunder clouds, which are accompanied by churning winds. All clouds are made of water vapor and tiny crystals of ice. Inside a thunder cloud, the rough winds knock the ice crystals around causing them to constantly melt and refreeze. In the process, the ice crystals grow in layers of clear ice and white granular ice. Eventually the winds knock the hailstones out of the cloud, and they fall to Earth.

Hailstorms don't last long, but they can cause serious damage. Balls of ice falling from the sky can injure people, damage houses and cars, and destroy crops.

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When did the last Ice Age end?

METEOROLOGY

1. 10,000 years ago
2. 20,000 years ago
3. 30,000 years ago

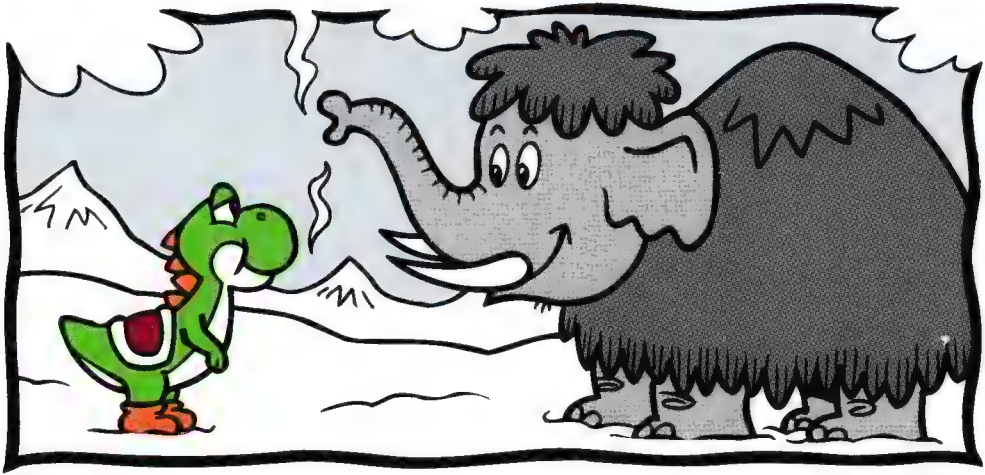

Illustration: Gary Fields

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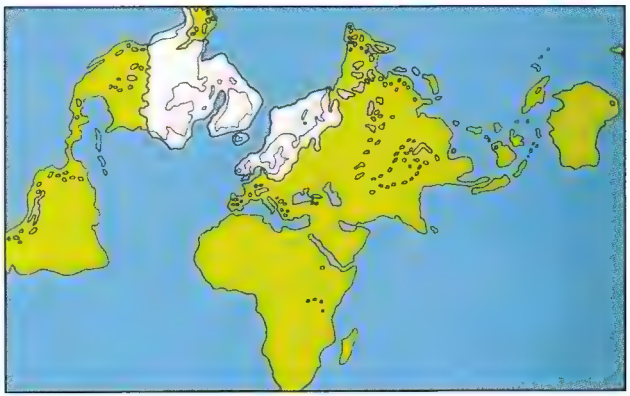
Ice Age

There have been at least five ice ages in Earth's history. Each one lasted at least 1 million years. The most recent one ended about 10,000 years ago.

1 The last Ice Age ended approximately 10,000 years ago.



© J. Dang

During the last Ice Age, most of North America and northern Europe was covered with ice (indicated by the white areas on the map). Some geologists think Earth is due for another Ice Age about 20,000 years from now.

The last Ice Age started about 2 million years ago. No one knows exactly why. During the Ice Age, Earth's air temperature dropped and oceans and inland waterways froze. This isn't unusual; it happens every winter in northern regions. But during the Ice Age, summer was almost as cold as winter, so the ice never completely melted. Instead, it grew layer upon layer until it was hundreds, even thousands, of feet thick. The ice covering Greenland and Antarctica is left over from the last Ice Age.

Possible Causes

No one has proven without a doubt what caused the Ice Age. One theory states that excessive dust in Earth's atmosphere prevented the warming rays of the Sun from reaching Earth's surface, thus lowering air temperature. Another possible cause is a change in Earth's path around the Sun which pushed our planet further from the Sun and lowered its temperature.

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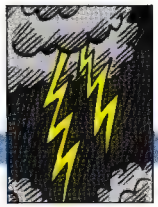
Can people predict when hurricanes will occur?



METEOROLOGY

1 No, hurricanes are unpredictable.

2 Yes, satellite pictures help people track hurricanes.

Illustration: Gary Fields

©1996 Nintendo

Hurricane Safety

Hurricanes can cause unbelievable damage and destruction, but because they can be tracked people can prepare for them.

2 Meteorologists use satellite weather photos to track hurricanes.

© Weather Stock / Sunset

Hurricanes usually strike between June and November. Their fierce winds can uproot trees, destroy cars and boats, and tear the roofs from houses.

Hurricanes develop over oceans and may take days to reach land. Meteorologists watch storms at sea as they grow and gather speed. When storms look like they might move toward land, meteorologists issue a storm "watch." When storms are definitely heading toward land the watch is upgraded to a "warning," which tells people to prepare for a storm.

Hurricane Season

To prepare for a hurricane, people tape or board up the windows of their homes so they won't shatter when struck by the winds. If they have time, they store or tie down lawn furniture, trash cans, and anything else that can blow around and cause damage. Then they find a safe place to wait out the storm. A room without windows is best—the basement or a closet or powder room near the center of the house. Hurricanes are fierce and frightening, but when people are prepared they can weather a storm safely.

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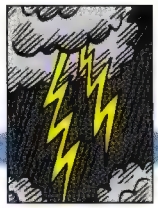
What is the name for cyclones in the western Pacific?



METEOROLOGY

1. Blizzards
2. Cowabungas
3. Typhoons

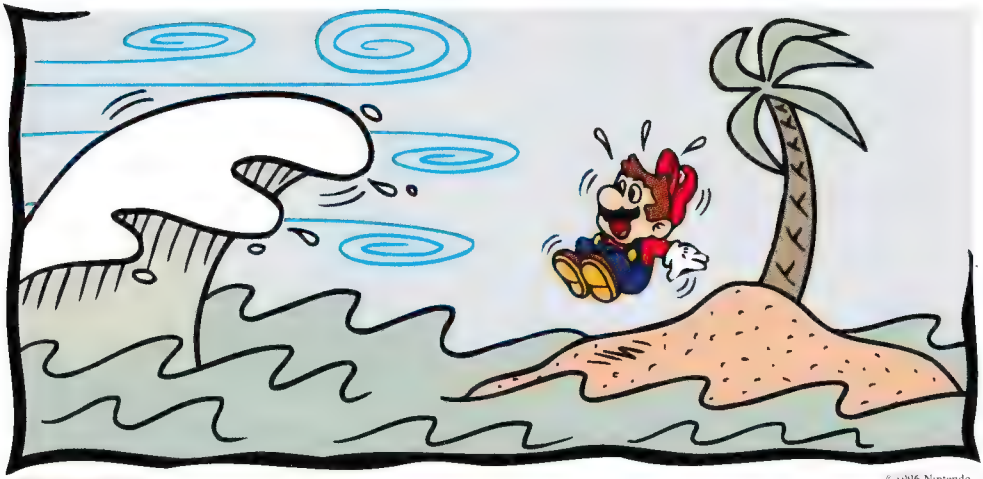


Illustration Gary Fields

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Typhoons

The word typhoon comes from the Chinese word *tai fung*, meaning "great wind." In Australia, the storms are sometimes called willy-willies.

3 Cyclones in the western Pacific are called typhoons.

© Weather Stock / Sunset

Typhoons usually strike Asia between the months of July and November.

The tropical cyclones, or wind storms, known as hurricanes in the Atlantic are called typhoons in the western Pacific. Typhoons are not significantly different from hurricanes in terms of structure or movement. The different names are used mainly to designate where the storm occurs.

Hot Winds

Typhoons usually form near the equator over warm ocean water. The South China Sea, which borders China, Vietnam, Cambodia, Thailand, Malaysia, Indonesia and the Philippines, is prime typhoon territory. Typhoons also occur as far north as Japan and in the Bay of Bengal around India, Sri Lanka, Bangladesh, and Myanmar.

Typhoons move in a northwesterly direction. In addition to fierce winds, typhoons also carry torrential rain which causes flooding.

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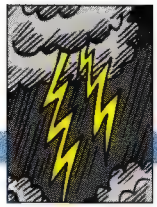
Why is the sky blue?



METEOROLOGY

1. Because Earth acts as a magnet
2. Because sunlight bounces off dust particles in the air
3. Because stars give off ultraviolet radiation

Illustration, Gary Fields

©1996 Nintendo

Color of the Sky

The color of the sky changes depending on the position of the sun.

2 Sunlight bouncing off dust particles in the air make the sky look blue.

© S. Conder / Explorer

The more dust and smoke particles in the air, the redder the sunset will be. Strangely enough, some of Earth's most beautiful sunsets occur in places with heavily polluted air.

White light from the sun is made up of different colored rays of light—red, orange, yellow, green, blue, and violet. Each colored ray has a different wavelength and travels at a different speed. Red rays have the longest wavelengths and move the slowest. Blue rays have short wavelengths and move fast.

Blue Skies

When the sun is high in the sky, fast-moving blue light rays reach Earth's atmosphere first. When they hit particles of dust, smoke, and salt in the air, the rays bend so that we see their color. That's why the sky appears to be blue.

Red Sails in the Sunset

As the sun sets below the horizon, its light rays have to travel through more of Earth's atmosphere to reach us. The blue rays bounce around so much that their light becomes dissipated, or weakened. This gives the slow-moving red rays a chance to break through. So, at sunset, the sky appears to be red.

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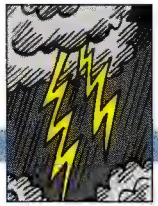
Can lightning occur during a snowstorm?



METEOROLOGY

1. No, lightning only occurs during rainstorms.
2. Yes, lightning occasionally occurs during snowstorms.

Illustration: Gary Fields

©1996 Nintendo

Lightning

Though we usually associate lightning with thunderstorms, it can occur during other types of weather activity, such as snowstorms and sandstorms.

2 Lightning occasionally occurs during snowstorms.

© Len Sirman

The temperature of a lightning stroke can reach 54,000°F (30,000°C)—six times the temperature of the surface of the sun. One stroke can carry an electrical charge of 100 million volts!

Lightning occurs between clouds and the ground, but even more lightning activity occurs in the sky between two clouds.

Electrical Energy

Inside a cloud, soft ice crystals scrape against water droplets creating static electricity. The particles take on negative or positive charges. Negative particles sink to the bottom of the cloud and positive particles rise to the top. When the opposing groups of charged particles build up enough, an electrical stroke, called a leader, escapes from the cloud.

Follow the Leader

You can't see the leader stroke. It moves toward the ground very quickly in a staggered pattern. As the leader approaches the ground, a second leader leaps up from the ground to meet it. When the two leaders touch, they create a flash of bright, white light, which is the lightning that we see.

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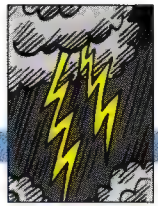
Which clouds exist at the highest levels?



METEOROLOGY

1. Altostratus
2. Cirrostratus
3. Cumulus

Illustration: Gary Fields

©1996 Nintendo

Cloud Elevation

Clouds are classified by their shape and by the elevations at which they exist.

2 Cirrostratus are the highest level of clouds.

© Goudoumeix / Explorer

Stratus clouds are low-level clouds that blanket the sky. In warm weather, they bring light showers. In cold weather, they bring snow.

Low-level clouds are made mostly of water. Puffy cumulus clouds, which settle at low levels in the sky, look like bright white mounds of cotton. They usually occur in separate, distinct masses. Cumulus are fair-weather clouds. They're most prevalent on sunny days.

Cumulonimbus are dark gray thunderclouds. They also settle low in the sky, and they bring rain, hail, and thunderstorms.

Middle-level clouds, which include altostratus and altocumulus, also are made mostly of water. They form layers that can block the sun.

High in the Sky

The top level of clouds are made of ice crystals. They include cirrus, cirrostratus and cirrocumulus. These clouds look like wisps of whiteness. They may be so thin that you can't see them at all.

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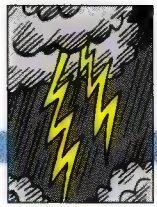
What is Earth's albedo?



METEOROLOGY

1. Temperature of Earth's core
2. Rate of rainfall in desert regions
3. Amount of the sun's energy reflected into space

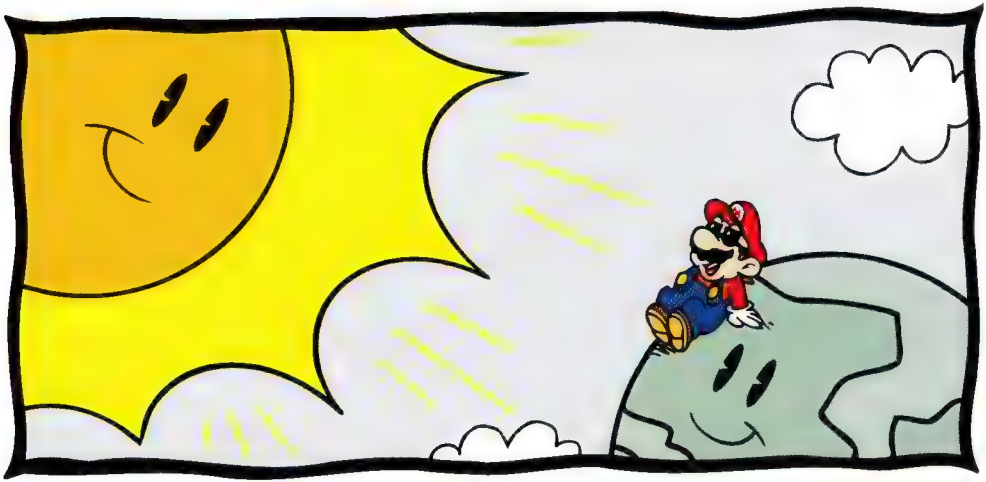


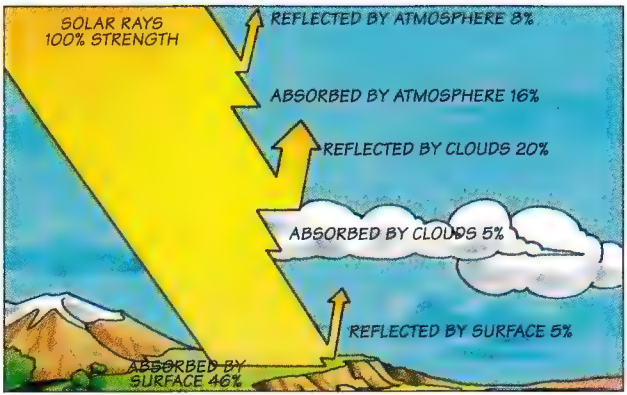
Illustration: Gary Fields

©1996 Nintendo

Albedo

Rays from the sun warm Earth and provide us with light, but much of the energy is reflected by Earth's surface. The amount of solar energy reflected by a surface is known as its albedo.

3 Earth's albedo is the amount of solar energy reflected into space.



© Y. Tabarnes

By the times the sun's rays reach Earth's surface, more than half their energy has been reflected or absorbed by our atmosphere.

Snow and ice have high albedos. They may reflect as much as 90 percent of the sun's warming rays. This is why icy polar regions remain frozen year-round. The albedo of a forest is relatively low. Forests may only reflect 10 to 15 percent of the sun's energy. The rest is absorbed by the trees and plants, which use solar energy to activate the process of photosynthesis.

Protective Cloud Cover

Much of the sun's energy never reaches Earth. It's reflected back into space by dust and gas in Earth's atmosphere and absorbed or reflected by clouds. In fact, by the time the sun's rays reach Earth's surface their energy has been depleted by more than half. Earth's atmosphere and clouds protect humans, wildlife, plants, and waters from the intense heat of the sun. Without this protective outer layer, Earth would be a very hot place indeed.

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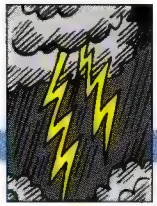
Which of the sun's rays provide warmth?



METEOROLOGY

1. Infrared
2. Shocking Pink
3. Ultraviolet

Illustration Gary Fields

©1996 Nintendo

Infrared Rays

Rays of energy from the sun vibrate in waves of various lengths. Rays with short wavelengths travel faster than rays with longer wavelengths.

1 Infrared rays from the sun provide warmth.

© Bhatia / P Resear / Explorer

The sun gives off warmth and light in rays of different colors and wavelengths. You can't see the infrared rays of the sun, but you can feel their warmth.

Many of the sun's rays occur within the visible spectrum. Each is a different color—red, orange, yellow, green, blue, and violet. Red waves are the longest in the spectrum. Blue and violet are the shortest. Infrared waves that carry warmth from the sun are even longer than the red waves. They're too long to be seen with the naked eye.

Useful Rays

Many machines and devices use infrared rays in helpful ways. The warmth you feel from the heater in your home is infrared radiation. Remote controls for TVs and VCRs work by transmitting infrared impulses. Some satellites in space are designed to detect infrared radiation. In 1983, one such satellite discovered a new star this way. The star was so young, it hadn't begun to give off visible light rays, but it was already producing heat in invisible infrared waves.

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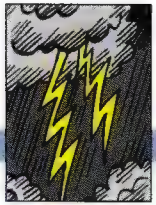
What instrument measures humidity in the air?



METEOROLOGY

1. Altimeter
2. Anemometer
3. Hygrometer

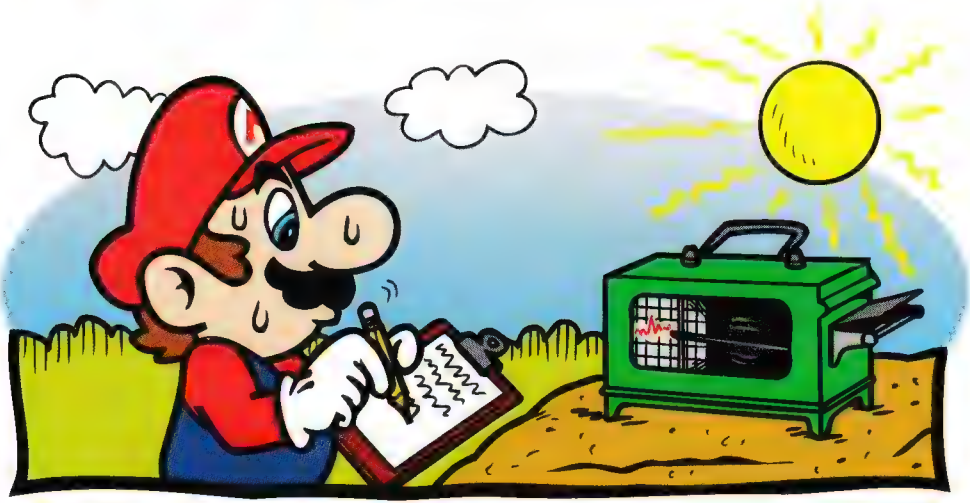


Illustration: Gary Fields

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Hygrometer

Humidity is the amount of water vapor in the air. Changes in humidity indicate changes in the weather.

3 A hygrometer measures humidity in the air.

© J. Fr / Optron Photo

Relative humidity readings indicate how close the air is to reaching its capacity to hold water. If relative humidity is 100 percent the air can't hold any more water.

A hygrometer measures humidity by absorbing moisture from the air and weighing it. One type is called a hair hygrometer. It uses a human hair to absorb water from the air. As the hair becomes more saturated it stretches. Expansion hygrometers use wood or paper to absorb the water.

Relative Numbers

The device used to measure relative humidity is a type of hygrometer called a psychrometer. It has two thermometers placed side by side. The first is the "dry bulb," which measures air temperature. The bulb of the other is covered with a wet piece of muslin. This one is called the "wet bulb." As the moisture of the muslin evaporates, the temperature goes down. The drier the air is, the lower the wet bulb temperature will be. The lower the wet bulb temperature, the lower the relative humidity is.

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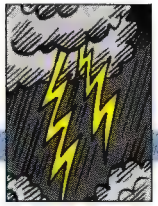
How do boaters and fishermen receive weather forecasts?



METEOROLOGY

1 By radio

2 By telephone

3 By telegram

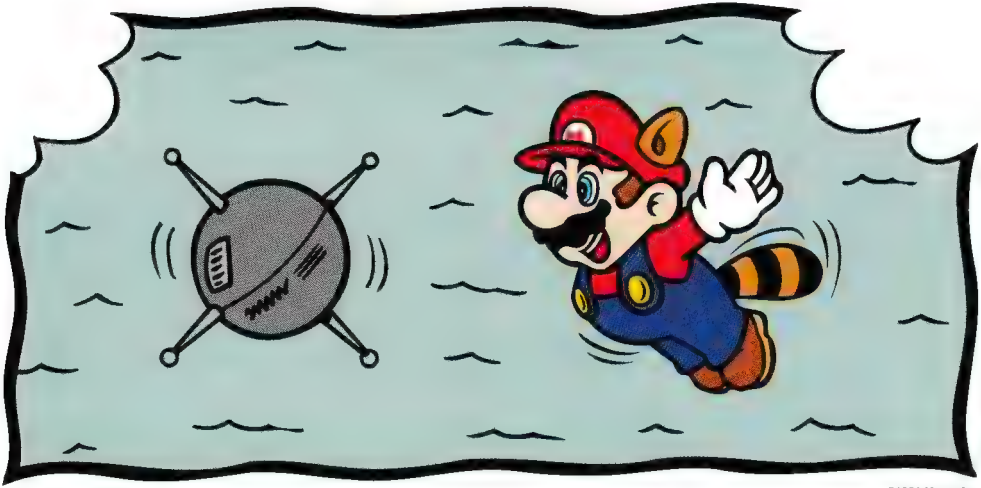


Illustration: Gary Fields

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Radios at Sea

Boaters and fishermen need detailed, current weather information so they can anticipate storms at sea. They receive weather reports on specially designated radio channels.

1 Boaters and fishermen receive weather forecasts by radio.

© Visuals Unlimited

Ships at sea have various methods to keep track of potentially dangerous weather conditions.

All pleasure and fishing boats carry radio transmitters. A two-way transmitter lets boaters receive information and communicate with other boaters, the Coast Guard, and marinas. Most shipboard transmitters are VHF, or Very High Frequency, transmitters. Like ordinary AM/FM radios, these transmitters can be tuned to a number of different channels.

One channel is reserved exclusively for emergency distress calls—like the police 911 telephone line. The Coast Guard monitors the distress channel.

Weather Reports

Another channel carries National Weather Service reports. New reports are broadcast every five minutes so boaters always have current weather information. With a weather facsimile, or "weatherfax" machine, boaters can even print weather maps, which are transmitted to the fax by radio signals.

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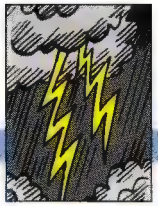
Can humans control a region's climate?



METEOROLOGY

1 Yes

2 No

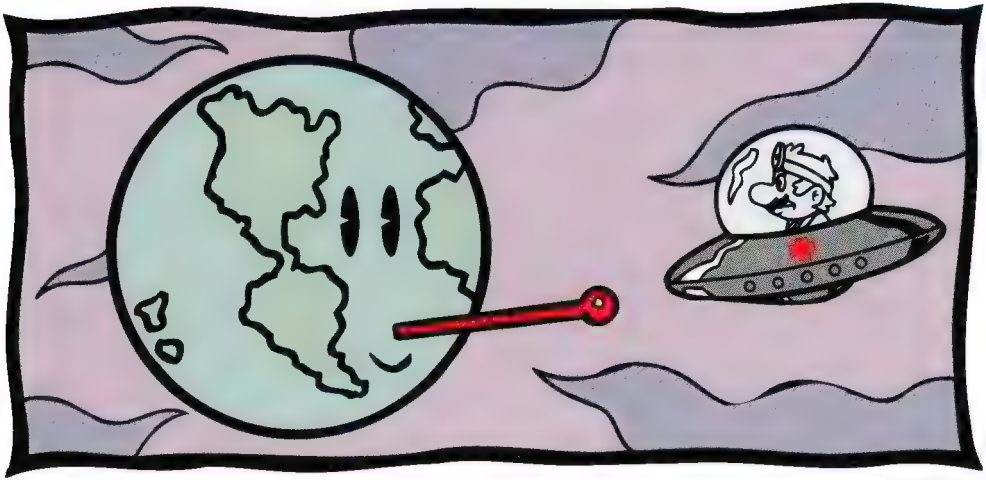


Illustration: Gary Fields

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Climate

Climate is the average temperature and weather in a given area. A region's climate depends on its proximity to the Equator, altitude, and proximity to a major body of water.

2 No, humans cannot control the climate.

© G. Lacz / Sunset

Factory smokestacks give off a variety of gases, such as carbon dioxide and methane. These "greenhouse gases" collect in the atmosphere and form a blanket of gas that doesn't allow the warmth of the sun to escape from Earth. This is known as the greenhouse effect.

Humans don't control the natural factors that influence climate, however, human activities can affect climate. Exhaust fumes from cars and factory smokestacks change the balance of gases in the air, and this can affect climate.

The greenhouse effect, caused by excess carbon dioxide and other gases in the air, creates a sort of gas blanket around Earth. It doesn't allow the sun's warming rays to escape. Over time, the greenhouse effect could raise Earth's temperature.

Ozone Hole

Gases called chlorofluorocarbons, or CFCs, released into the air by aerosol cans and air conditioners, are causing another climatic change. As they collect in the atmosphere, CFCs appear to be eating a hole in the layer of ozone gas that protects Earth from the sun's ultraviolet rays.

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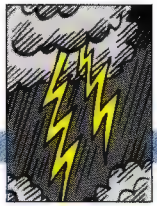
Is it ever too cold to snow?



METEOROLOGY

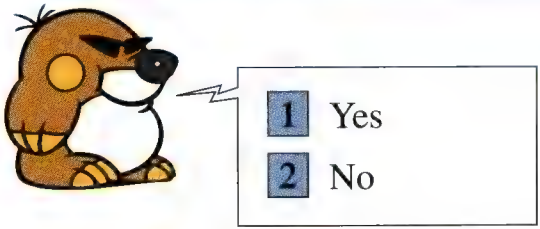


Illustration: Gary Fields

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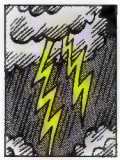
Snow

It's a common misconception that there are days when the air is too cold for snow to fall.

2 No, it's never too cold to snow.



© C. Nardin / Explorer

If air temperature is below freezing, precipitation from clouds falls to Earth as snow.

Snow is formed from ice crystals that cluster together inside clouds. When the clumps of crystals become heavy enough, they fall from the clouds.

Clouds in which ice crystals form are high in the air where temperatures are very low. As the ice crystals fall, they pass through progressively warmer layers of air. Once the air temperature rises above freezing, 32°F (0°C) the ice crystals melt and fall to Earth as rain. If the air temperature is below freezing all the way down, the crystals remain frozen and they fall to Earth as snow.

Baby It's Cold Outside

Some people think the air can become too cold for snow because very cold air from the north has a clearing effect on weather conditions. In other words, the cold air blows the clouds away. But that doesn't mean cold air prevents snow. At the South Pole, where air temperatures can reach -128°F (-89°C), snow falls regularly.

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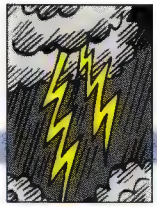
What is the difference between an avalanche and a landslide?



METEOROLOGY

1. Avalanches move faster.
2. Landslides involve mainly rock and soil; avalanches mainly involve snow.
3. Nothing, they're the same.

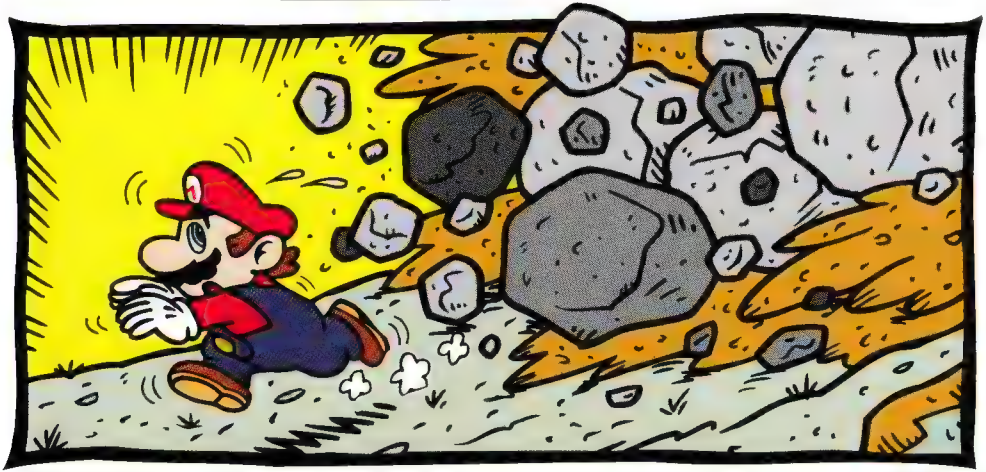


Illustration: Gary Fields

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Avalanche

Avalanches, which involve snow sliding down the side of a hill or mountain, usually occur in spring when snow begins to melt. Landslides can occur at any time of year, particularly after severe rains.

2 Landslides mainly involve rock and soil; avalanches involve snow.

© Linnier / Jerrican

In ski areas, signs may be posted to warn skiers away from parts of the slopes where avalanches could occur.

Both landslides and avalanches are massive movements of surface materials down a slope. The surface materials may be rock and soil or they may be snow.

Too Much Weight

When a part of a slope becomes too weak to support the weight above it, it begins to crumble. This allows the surface material to slide downhill. If there's not much material, the slide usually stops on its own when it hits level ground or when it spreads out and loses its momentum, or natural force.

Damage Control

Small avalanches and landslides can occur at any time on mountainsides. Usually, they don't disturb any human or animal activity. However, if a landslide or avalanche occurs near a populated or forested area, the force of the downhill slide can cause a great deal of damage.

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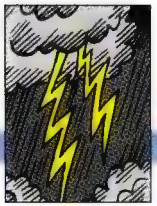
Which is characteristic of Earth's temperate zones?



METEOROLOGY

1. Dry weather year-round
2. Moderate temperatures and enough rain to sustain life
3. Extreme cold for most of the year

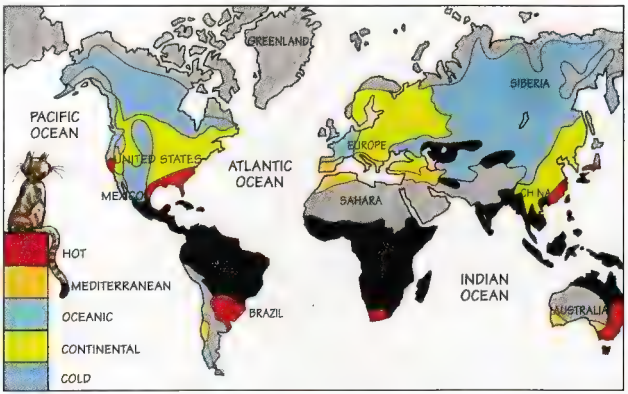
Illustration, Gary Fields

©1997 Nintendo

Temperate Zones

Earth's temperate zones are located in the mid latitudes, far enough from the equator to be comfortably cool, yet far enough from the poles to be comfortably warm.

2 Temperate zones have moderate temperatures and evenly distributed rainfall.



©J Dang

On this map, gray areas indicate desert or polar climates. Black areas indicate tropical climates.

The equator is the imaginary line running around Earth's center. At the equator, temperatures remain consistently hot. On either side of the equator—to the north and the south—are the tropics. Here, the weather is generally warm and wet. Beyond the tropics are regions known as mid latitudes, and this is where most of Earth's temperate zones lie.

Pleasant Weather

Much of the United States, Europe, and eastern Asia are temperate climates. They have warm summers and cool or cold winters, with rainfall throughout the year. Regions with Mediterranean climates, such as California and southern Italy, have hot summers and warm, wet winters. Physical geography, such as mountains and coastlines, also affects a region's climate. So, two regions on the same latitude can have markedly different climates if their physical geography is different.

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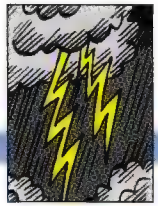
Where is the place that records the most annual rainfall on Earth?



METEOROLOGY

1. Brisbane, Australia
2. London, England
3. Mount Waialeale, Hawaii

Illustration, Gary Fields

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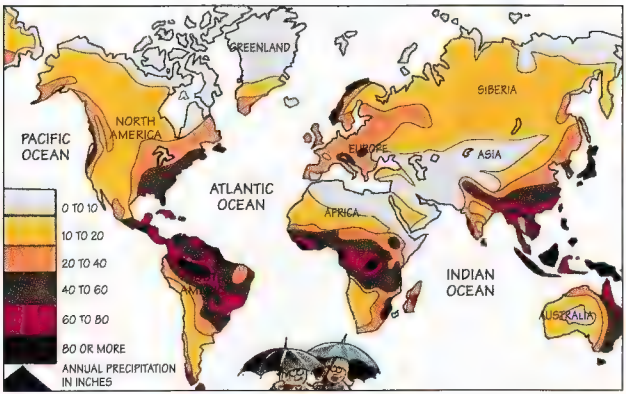
Rainfall

Mount Waialeale in Hawaii receives about 460 inches (1,168 cm) of rain each year.

3 Mount Waialeale records the most annual rainfall.



Deserts and frozen areas receive little rain. Tropical Southeast Asia and the Amazon region of South American receive a lot of rain.

The second rainiest place on Earth is Cherrapunji, India, which gets about 450 inches (1,143 cm) per year. Even more remarkable is the fact that Cherrapunji receives almost all of its rain during a six-month period.

In India, as well as central South America, northeast Africa, and Southeast Asia, heavy rains from June to December are usually carried by winds called monsoons. The winds bring rain from the Indian and Pacific Oceans to the land. Monsoon season provides virtually all of a region's annual rainfall.

Rain on High

Mountains, like Hawaii's Mount Waialeale, receive a lot of rain because the face of the mountain deflects moist winds upward and forces them to produce rainstorms. So, the side of the mountain facing the wind receives a lot of rain, but the opposite side—known as the leeward side—receives very little.

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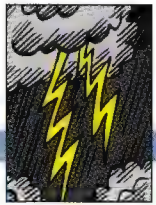
How many seasons do we have in North America?



METEOROLOGY

1 One
2 Two
3 Four

Illustration Gary Fields

©1997 Nintendo

Seasons

In most parts of North America there are four distinct seasons: cold winter, warm spring, hot summer, and cool autumn.

3 We have four seasons in North America.

© Crampon / Jerrican

In the hot months of summer, people head for the beach for fun in the sun.

In hot, tropical places, such as islands of the Caribbean, there really are just two distinct seasons: wet and dry. Even in some of the southernmost places in the U.S., such as south Florida, winters are not severely cold and snowfall is rare.

Watching the Plants

In North America, and other mid latitude regions such as Europe, we judge the passing of the seasons by their affect on the plants around us. In spring, plants begin to produce new leaves and buds. Some flowers bloom. By summer, trees are covered with fresh green leaves and plants and flowers grow tall. In autumn, deciduous trees shed their leaves, most flowers wither and die, and plant growth slows. In winter, tree branches are bare, and most of a plant's preparation for the next growing season takes place underground or in pods protected from the cold.

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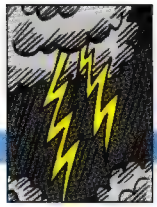
What does the Beaufort scale measure?



METEOROLOGY

1. Lightning voltage
2. Rainfall
3. Wind velocity

Illustration, Gary Fields

©1997 Nintendo

Wind Velocity

The Beaufort scale, developed in 1806 by Admiral Francis Beaufort, provided a way to categorize wind by speed and force.

3 The Beaufort scale measures wind velocity.

© B. Wisser / Liaison / Gamma

A hurricane force wind, that can cause this type of devastation, measures 12 on the Beaufort scale. Hurricane winds reach speeds of 64 knots or more.

Beaufort, an admiral in the British navy, created the wind speed scale to help mariners. The scale —which runs from 0 to 12—was originally based on the wind's observable effects on a fully rigged sailing ship. If the sails on the ship were completely limp and the sea was perfectly smooth, then the wind would measure 0 on the Beaufort scale. A gentle breeze that makes a light flag ripple would register as a 3 on the Beaufort scale. At the top of the scale, 12 indicates hurricane force winds.

On Land

The scale was later modified to reflect the wind's effects on land. So, a light breeze that causes leaves to rustle would rate a 2, and a whole gale with the power to uproot trees would register a 10.

Knots To You

Today, wind speed is usually measured in knots. One knot equals 1.15 miles per hour (1.85 km/h).

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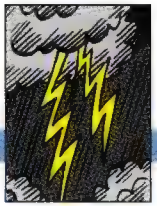
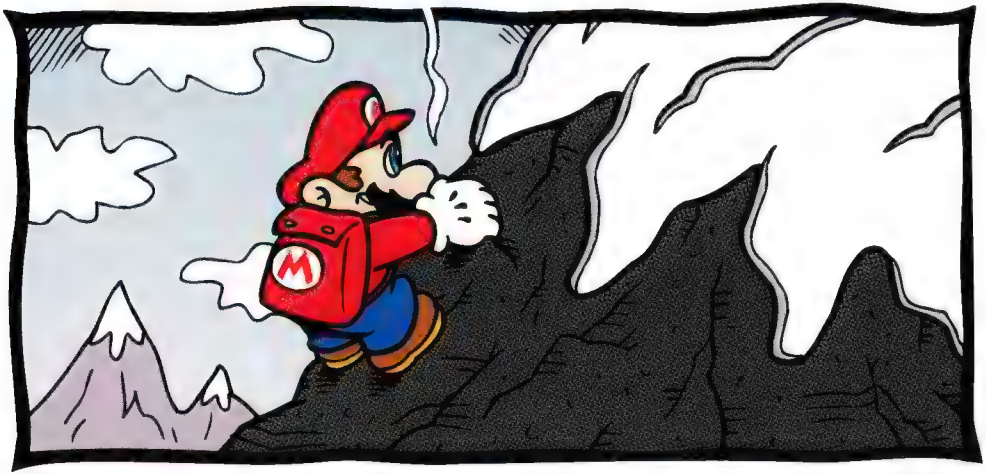
D3 054 82-17

As altitude increases, what happens to temperature?



METEOROLOGY

1. It increases
2. It decreases
3. It stays the same



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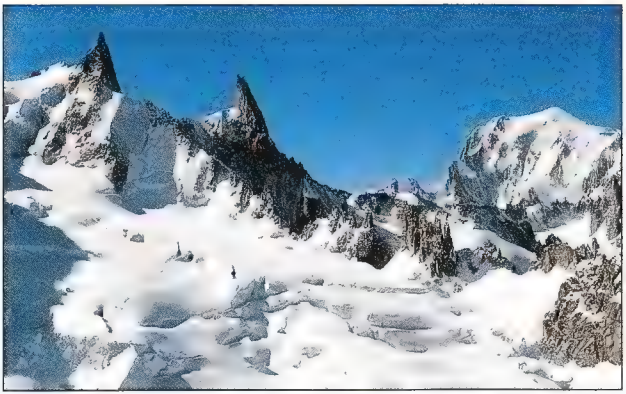
Altitude

For every 1,000-foot increase in altitude, temperature decreases 3 1/2°F.

2 Temperature decreases as altitude increases.



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Because temperature decreases as altitude increases, mountains may have snowy peaks even when the ground temperature is well above freezing.

In Earth's troposphere, the layer of the atmosphere nearest the ground, temperatures decrease the higher you climb. So, even in equatorial regions, generally the hottest areas on Earth, high mountains may have snowy peaks.

The troposphere extends to about 6 miles (10 km) above Earth's surface. Its average temperatures range from 60°F (15°C) near the surface to -75°F (-60°C) at the top.

Outer Limits

The conditions are reversed once you travel beyond the troposphere into the stratosphere. The stratosphere contains Earth's ozone layer, a band of gas that absorbs the sun's ultraviolet rays and prevents them from reaching Earth. This protective layer keeps the troposphere cool, and it keeps heat contained in the stratosphere. So, temperatures in the stratosphere range from -75°F (-60°C) at the bottom to about 50°F (10°C) as you approach the sun.

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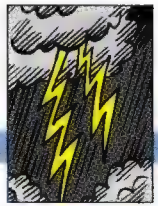
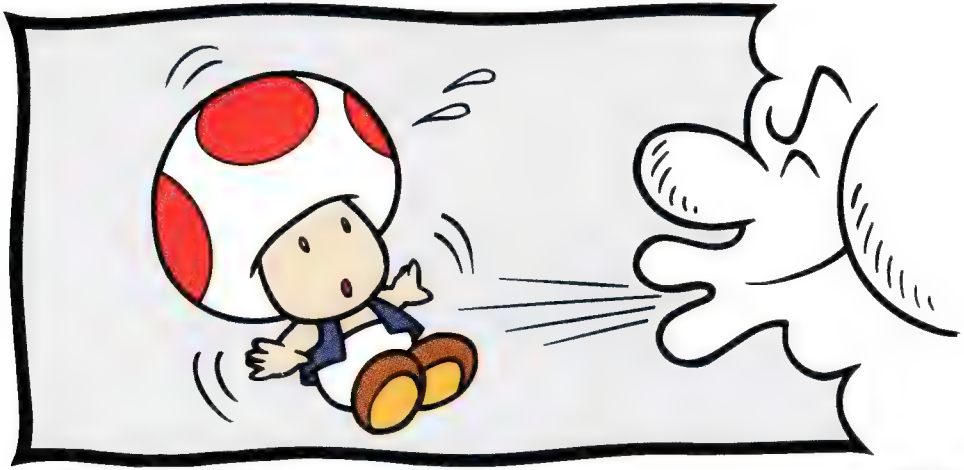
What are chinooks and siroccos?



METEOROLOGY

1. Devices for gauging temperature
2. Foul-weather gear
3. Types of winds



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Wind

Besides the hurricanes and tornadoes that we know in North America, there are many unusual wind conditions throughout the world.

3 Chinooks and siroccos are types of winds.

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People around the world have different words to describe the wind and wind conditions. In the Philippines, a tropical cyclone is called a baguio.

A chinook is a dry, warm wind that comes down from a mountain to the flatlands below. In the United States, the term "chinook" describes wind that travels down the eastern slopes of the Rocky Mountains. It can raise ground temperatures as much as 18°F (10°C) in a few hours. The same phenomenon is found throughout the world. In the Alps of Europe it's known as a foehn, from the Latin word meaning "west wind." In South Africa it's called the Berg.

Desert Winds

A sirocco is a hot, dusty wind from the Sahara that travels all the way to the Mediterranean countries of Europe. Hot dusty winds that blow across the Sahara are called simooms, from the Arabic word for poisonous.

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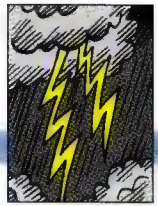
What happens when a cold front meets warm air?



METEOROLOGY

1. It pushes warm air upward
2. It pushes warm air downward
3. They stop moving

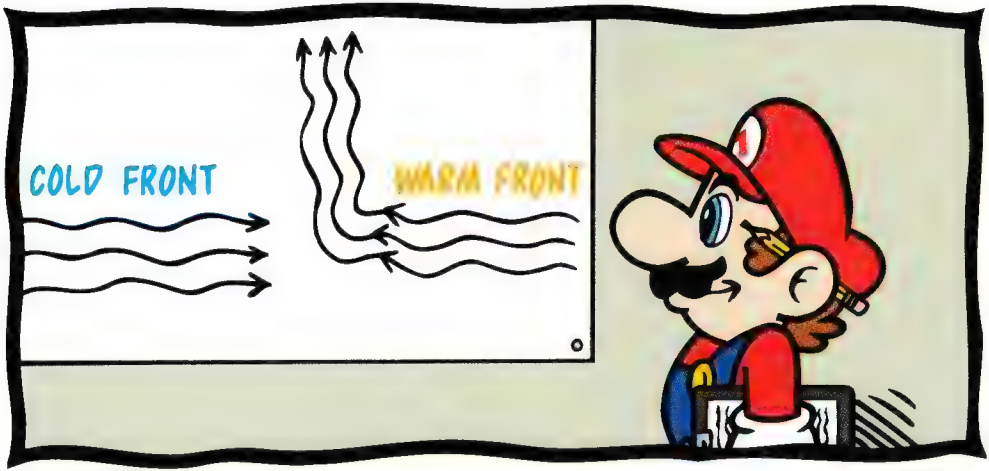


Illustration Gary Fields

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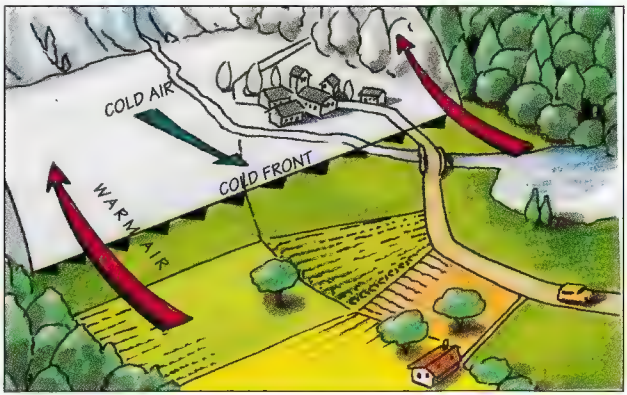
Cold Front

Imagine two air masses, one cold and one warm. At the point where the two masses meet, they create a flattened zone, called a front.

1 Cold fronts push warm air upward.



© Y Tabanés

When a cold front meets warm air, it forces the warm air to rise. A drop in temperature follows the cold front.

If the cold air mass is moving forward toward the warm air mass, the front is known as a cold front.

When a cold front comes in contact with a warm air mass, the humid warm air is forced upward because warm air is lighter than cold. This sharply rising warm air produces thunderclouds which bring short but severe rainstorms. The storms may be so fierce that they result in tornadoes.

A Chill in the Air

The cold front paves the way for a mass of cold air to follow. Sometimes the air temperature drops as much as 15 degrees in an hour when a cold front moves through. As the cold front passes, the air becomes drier as well. A few small showers may linger after the thunderstorms, but these are usually followed by clear skies.

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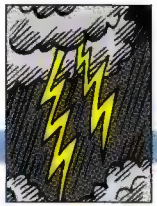
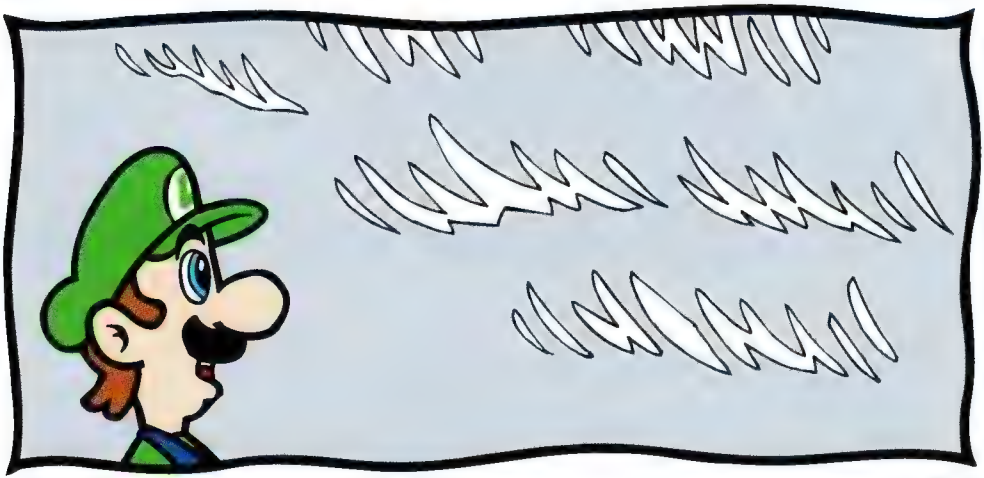
Which clouds mark the arrival of a warm front?



METEOROLOGY

1. Cirrus
2. Cumulus
3. Nimbus



Illustration, Gary Fields

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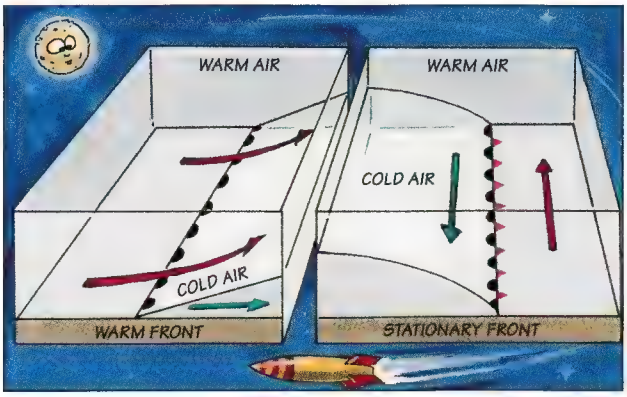
Warm Front

A warm front is a flattened zone of air at the point where a warm air mass meets a cold air mass.

1 **Cirrus clouds mark the arrival of a warm front.**



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Air flattens at the point where warm and cold air masses meet, forming a front. When a warm front meets a cold air mass, the warm air rises gently over the cold, creating steady rain, sleet, or snow.

"Front" is the meteorological term for the point at which warm and cold air masses meet. In this zone, the air forms a flattened boundary. When the cold air moves toward the warm, the zone is called a cold front. When the warm air moves toward the cold, it's called a warm front.

Warm Winds

As a warm front approaches an area, the air temperature rises and humidity moves in. As the front passes through, a mass of warm air follows behind it.

Slow Rise

As the warm front approaches a cold air mass, the warm air rises in a gentle slope above the cold. This is known as overrunning. As the warm, humid air rises it gives off moisture in the form of precipitation. Depending on the temperature of the cold air below it, the precipitation may be rain, snow, or sleet.

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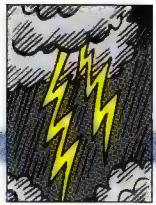
What is a drought?



METEOROLOGY

1. A dust storm
2. Prolonged period of dry weather
3. Prolonged period of rainy weather

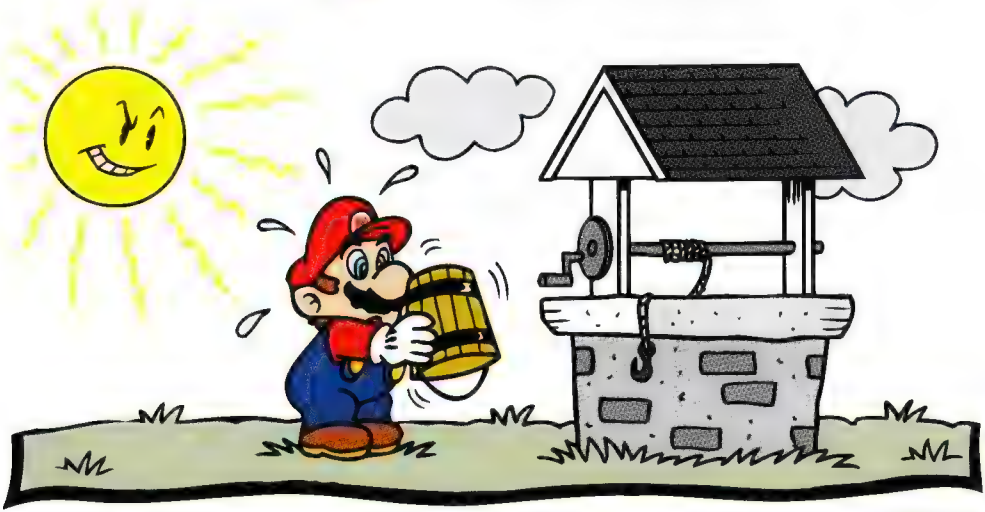


Illustration Gary Fields

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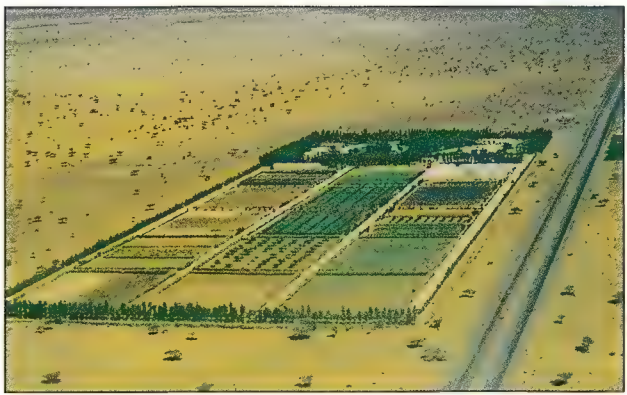
Drought

Regions immediately north and south of the equator experience constant conditions of hot, dry wind and little rain which leaves them in a permanent drought state.

2 A drought is a prolonged period of dry weather.



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In Israel, desert land is irrigated so that crops can grow in spite of permanent drought.

A drought is a period of 15 days or more during which rainfall measures less than 0.01 inches (0.25 mm). While some places are more prone to drought than others, drought may occur almost anywhere. In drought conditions, crops and livestock die from lack of water. In severe cases, drought can lead to widespread famine.

Desert Farming

Humans have developed ways to counteract the effects of permanent drought. In desert nations, such as Israel, efficient irrigation systems deliver water to the parched land so that crops can grow. Reservoirs are built to catch and retain rainfall so that there's always some available water. And even when the land is completely dry, water can be found in underground springs and water-filled layers of rock called aquifers.

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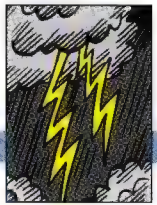
Which is used by meteorologists to track storms?



METEOROLOGY

1. Quasar
2. Radar
3. Scalar

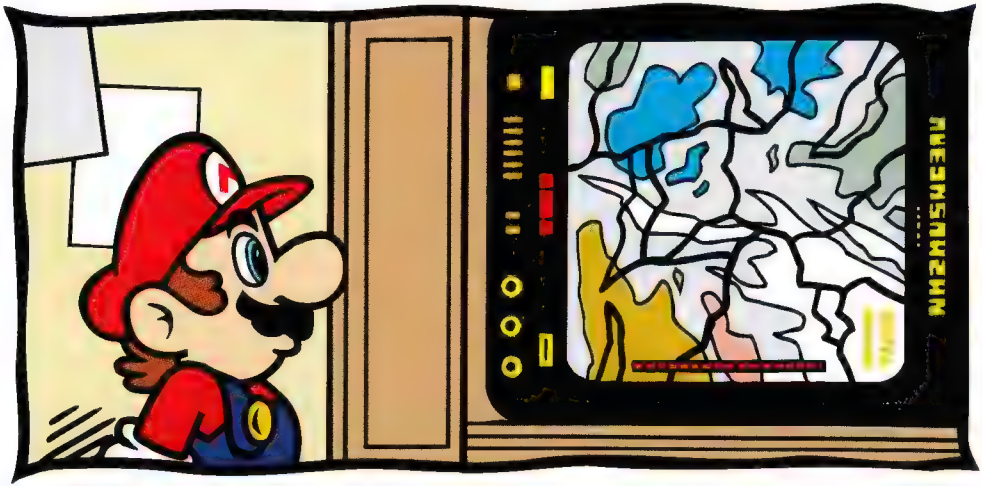


Illustration: Gary Fields

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Radar

Beginning in 1992, the National Weather Service began upgrading its weather radar system throughout the United States.

2 Radar is used to track storms.

© P. Landmann / Gamma

Weather radar, such as the new NEXRAD system being used by the National Weather Service in the U.S., detects and follows the paths of precipitation and storms.

The "next generation" of weather radar—known as NEXRAD—is more sensitive and more accurate than earlier weather radars. It is being installed in about 150 weather stations throughout the country.

NEXRAD is being used by weather forecasters to predict and report the weather. It's also an important tool for pilots, who rely on radar to inform them of weather conditions on their flight route.

Eye on the Sky

In addition to being able to identify and track large storms, such as hurricanes, NEXRAD is able to detect atmospheric conditions such as turbulence and wind shear. Before now, pilots often were unable to spot these dangerous conditions until they encountered them.

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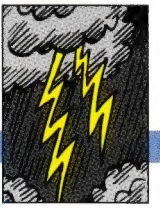
During a storm, can you determine where lightning strikes?



METEOROLOGY

1 Yes, you can determine it during the storm.

2 No, you can't determine it until the storm is over.

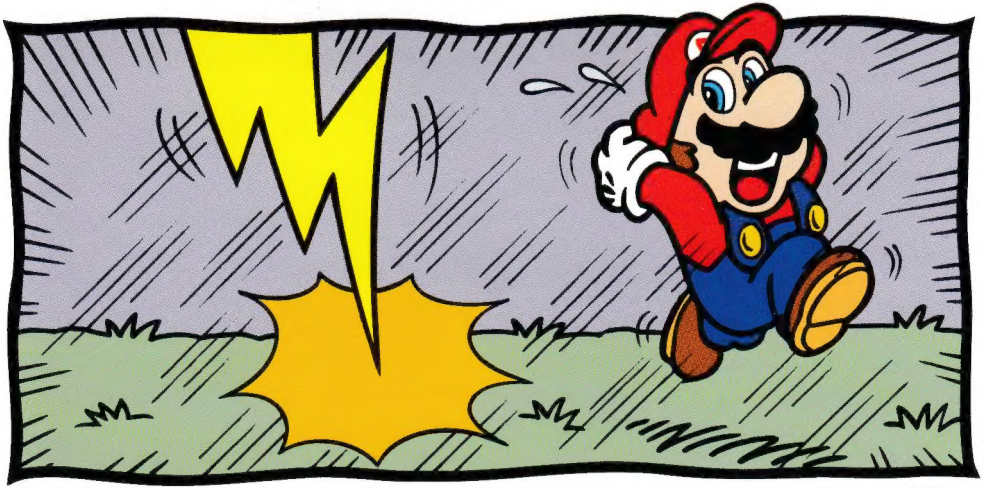


Illustration: Gary Fields

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Lightning

Count the time between the visible flash of lightning and the sound of thunder and divide by 5. This tells you how many miles away the lightning is.

1 Yes, you can determine where lightning strikes during a storm.

© N. Medina / Explorer

Tall buildings, especially those that are surrounded by low buildings, are prime targets for lightning. They are usually topped with lightning rods, which diffuse the charge and protect the building.

Lightning is enormously hot. When it strikes, it instantly heats the air around it. This causes the air to expand quickly, creating a rumbling sound which we know as thunder. The lightning and the thunder happen at the same time. However, because light travels faster than sound, we see the lightning before we hear the thunder. Light travels about 5 seconds faster per mile (1.6 km) than sound does. So, if there's a five second gap between the time you see lightning and the time you hear thunder, it means that the lightning is 1 mile (1.6 km) away. The shorter the gap, the closer the storm.

Return Engagement

It's not true that lightning never strikes the same place twice. Skyscrapers, such as the Empire State Building in New York City, may be struck by lightning many times—sometimes more than once in the same storm.

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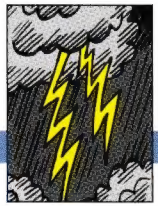
Who invented the lightning rod?



METEOROLOGY

1. Thomas Edison
2. Benjamin Franklin
3. Thomas Jefferson

Illustration: Gary Fields

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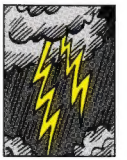
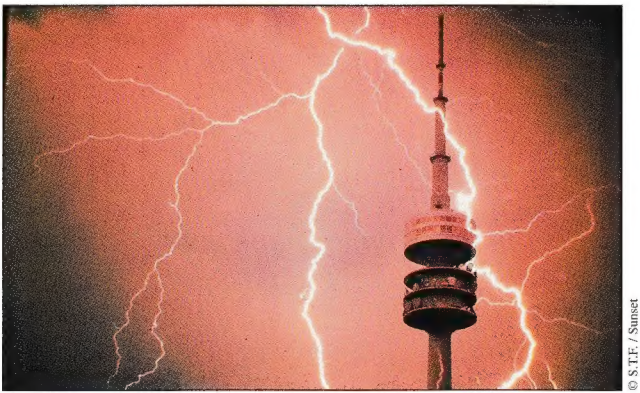
Lightning Rod

Because lightning generally strikes the highest point in its vicinity, lightning rods are attached to the tops of buildings to attract the lightning.

2 Benjamin Franklin invented the lightning rod.





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Lightning generally strikes the tallest structure in its vicinity. This can mean a skyscraper in a city, a tall tree in an open field, or a lightning rod on top of a building or tower.

A lightning rod is a metal pole that is attached to the roof or near the top of a building to protect it from lightning damage. The lightning rod intercepts the lightning before it can hit the building. It absorbs the charge and sends it safely to the ground.

A lightning rod has a sort of halo effect. Not only does it protect the building on which it stands, but it also protects lower buildings nearby. The higher the lightning rod is, the broader the area it protects.

Franklin's Creation

Benjamin Franklin, the 18th-century scientist and statesman, was the first to demonstrate that lightning is a form of electricity. He was also the first to develop the lightning rod to protect buildings against lightning. Franklin's first lightning rod was installed in 1752.

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